A BRIEFING ON CONCEPT DESIGN AND OPERATION FOR THE CORE INSTRUMENTATION SUBSYSTEM AT THE NATIONAL TRAINING CENTER

SCIENCE APPLICATIONS, INC.

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This report has been reviewed and approved for distribution.

Project Manager

Department Manager

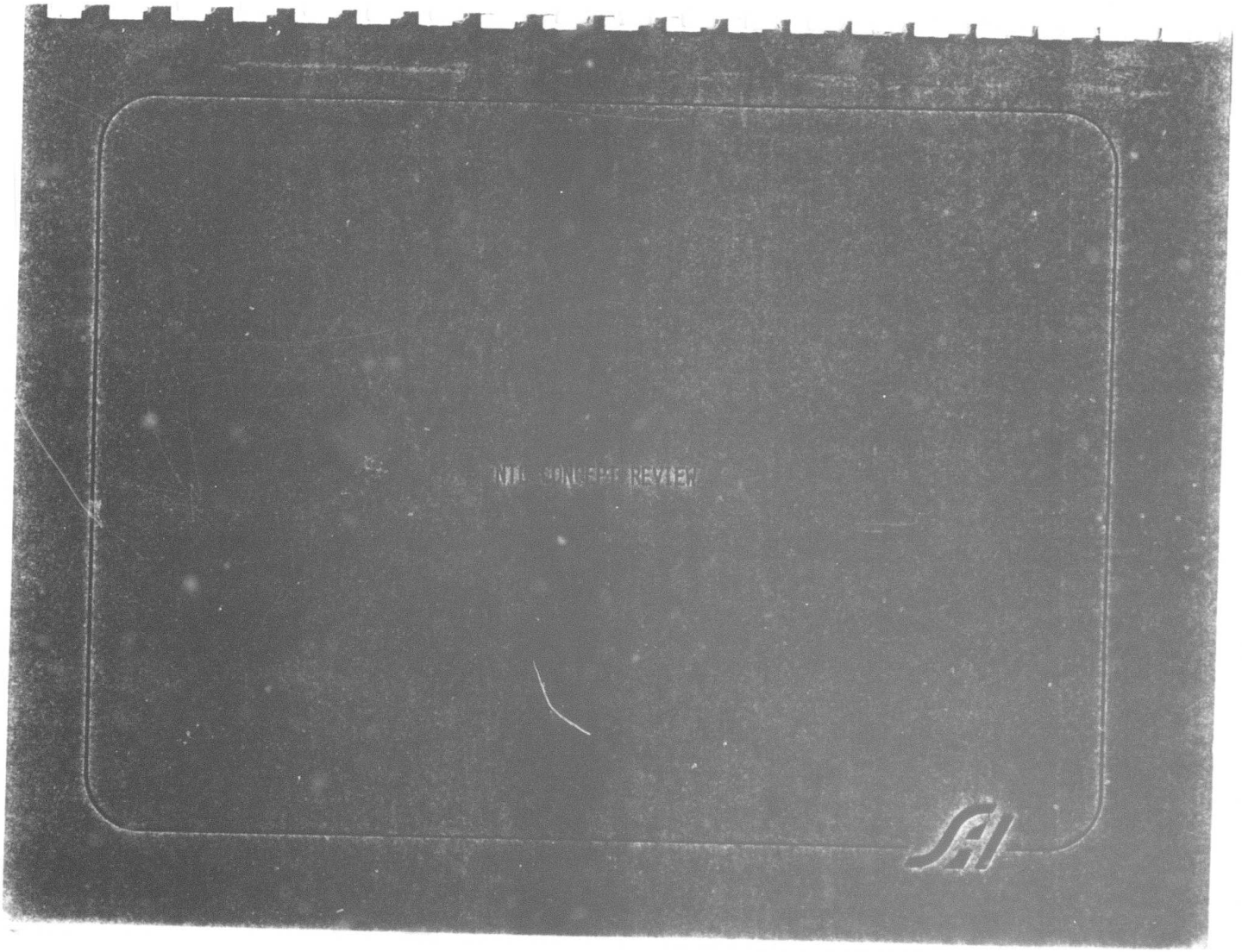
[redacted]

BRIEFING AGENDA

Contents includes:

- NTC (National Training Center) CONCEPT REVIEW;
- CONTROL CENTER OPERATIONS;
- ARTILLERY/AIRSTRIKES METHODOLOGY; and
- DIGITAL TERRAIN DATA BASE.

SAI



THE NTC MISSION

"THE NATIONAL TRAINING CENTER (NTC) IS A FACILITY WHERE HIGHLY REALISTIC, INTENSIFIED TRAINING WILL BE CONDUCTED - - - - BATTLE REALISM, EVALUATION, AND FEEDBACK IN THIS ENVIRONMENT REQUIRE INSTRUMENTATION AND COMPUTER SUPPORT TO PROVIDE THE PLAYERS WITH OBJECTIVE ASSESSMENT AND ANALYSIS OF UNIT PERFORMANCE, WITH SUFFICIENT DETAIL AND TIMELINESS TO IMPROVE COMBAT EFFECTIVENESS."

TRADOC/DARPA - 1979 NTC CONFERENCE

THE UNIT TRAINING NEED

"THE WORST THING THAT CAN HAPPEN IS FOR A SOLDIER AND A UNIT TO FIND THEMSELVES ON A BATTLEFIELD, FIGHTING IN ANGER FOR THE FIRST TIME AND NEVER TO HAVE EXPERIENCED ANYTHING LIKE IT BEFORE."

GEN. BERNIE ROGERS

- U.S. ARMY WILL FACE NUMERICALLY SUPERIOR ENEMY WITH QUALITATIVELY EQUIVALENT WEAPON SYSTEMS
- WON'T HAVE TIME TO LEARN ON THE JOB
- MUST TRAIN AS THEY WILL FIGHT
- TRAINING CAN PROVIDE THE FORCE MULTIPLIER TO EQUALIZE/DEFEAT ENEMY SUPERIOR SIZE

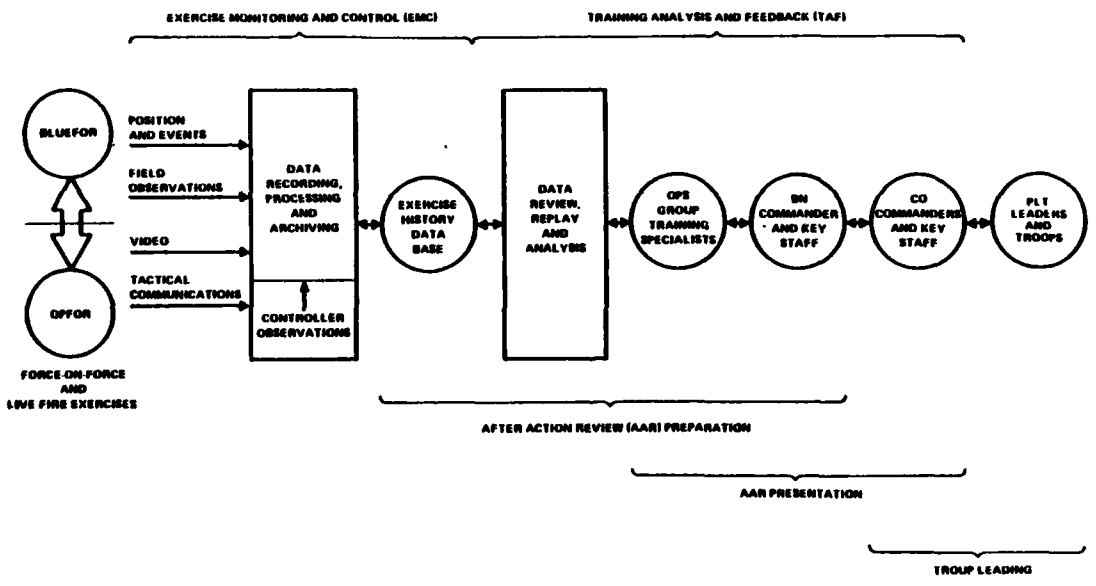
SAI

NTC TRAINING CONCEPT

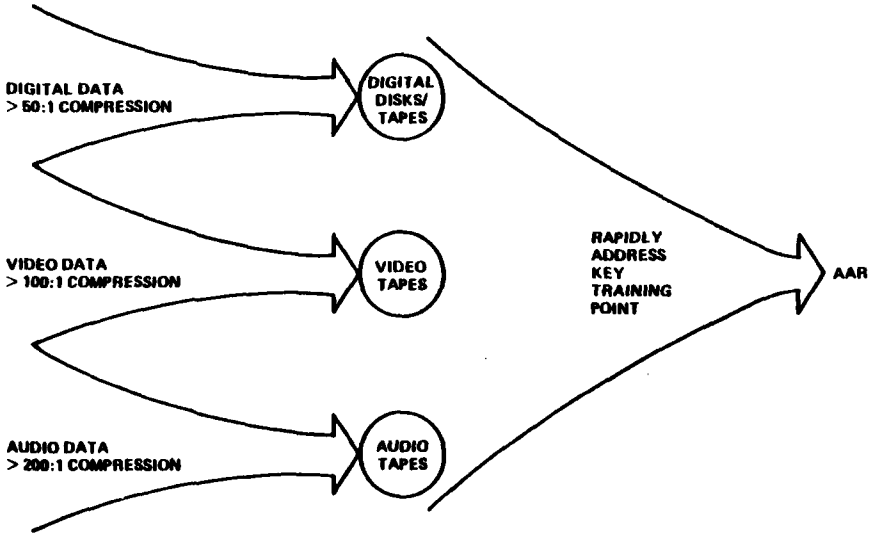
- REALISTIC EXPERIENTIAL UNIT TRAINING (BDE/BN)
- FORCE-ON-FORCE EXERCISE: CONTROLLED FREE PLAY
  - FOURTEEN-DAY EXERCISE WITH MULTIPLE MISSION SEGMENTS
  - PERMANENTLY STATIONED PROFESSIONAL OPPOSING FORCE
  - EYE-SAFE LASER DIRECT-FIRE WEAPON SIMULATORS
  - POSITIVE YET NON-INTRUSIVE EXERCISE CONTROL
  - TIMELY, FREQUENT, AND OBJECTIVE TRAINING CRITIQUES
- LIVE FIRE EXERCISE
  - OFFENSIVE AND DEFENSIVE EXERCISE RANGES
  - OPPOSING FORCE SIMULATED BY ABOUT 1,000 ARMOR/INFANTRY TARGETS
  - REALISTIC OPFOR SCENARIOS GENERATED BY COMPUTER SIMULATION AND CONTROL OF TARGET ARRAY
  - IN-DEPTH AND OBJECTIVE TRAINING CRITIQUES
- TAKE-HOME TRAINING PACKAGE
  - REMEDIATION
  - SUSTAINMENT

SAI

NTC TRAINING FEEDBACK APPROACH

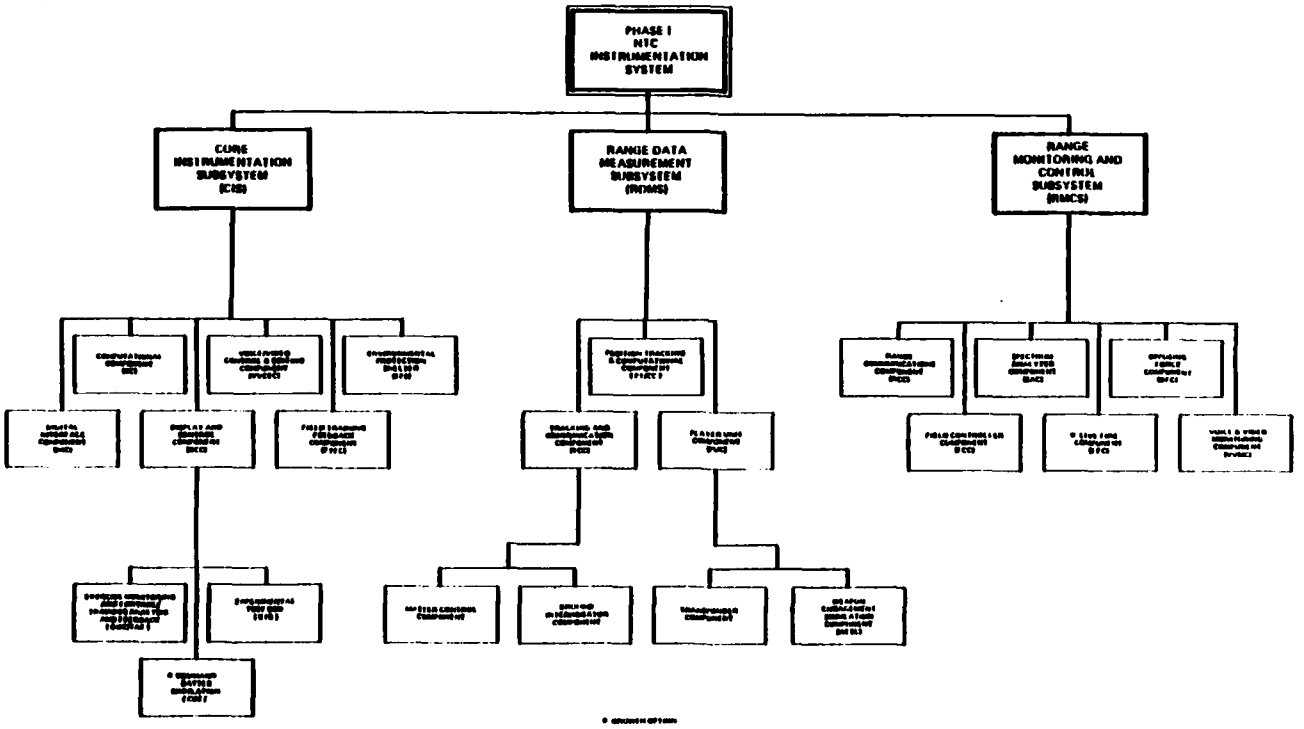


TAILORING OF DATA TO SUPPORT SPECIFIC AAR

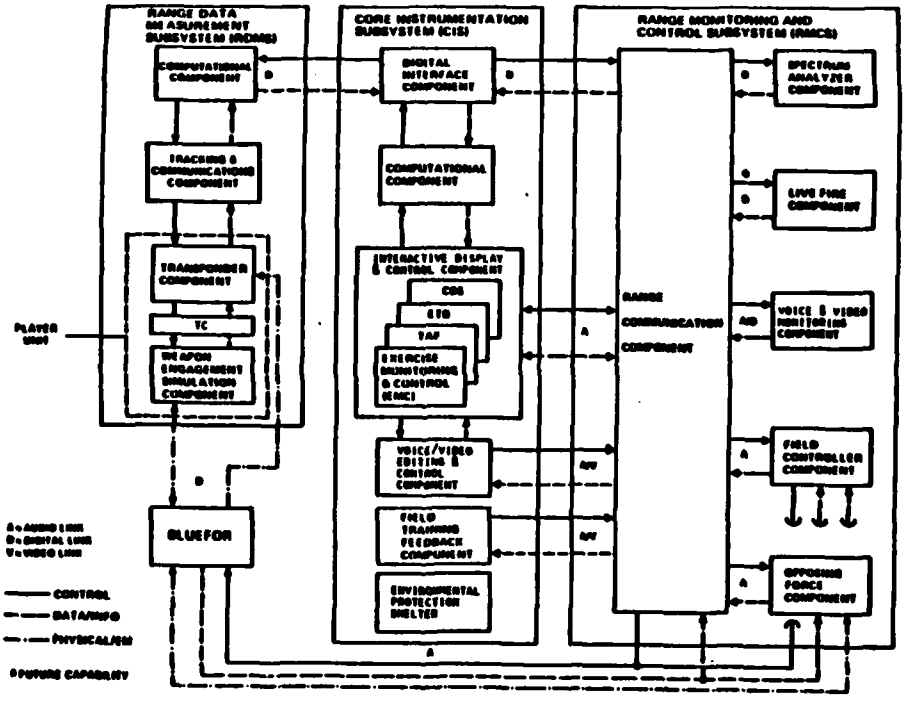


KEY ATTRIBUTES DRIVING NTC DESIGN

- LARGE UNIT (BTF) FIELD MANEUVER AND COMMAND POST EXERCISE TRAINING (SIMULTANEOUS COORDINATION OF ES AND CBS)
- COMBAT REALISM WHILE MAINTAINING SAFETY (NON-INTRUSIVE POSITIVE CONTROL)
- PRODUCTION TRAINING SCHEDULE (40+ BTFs PER YEAR)
- NEAR-REAL-TIME TRAINING AND READINESS FEEDBACK (AFTER ACTION REVIEW (AAR) 30 MIN. AFTER EACH EXERCISE SEGMENT)
- SUPPORT FORCE READINESS ASSESSMENT (COMBAT DEVELOPMENTS) WITHOUT INTERFERING WITH "PRODUCTION" TRAINING OPERATIONS
- NEED TO CONDUCT TRAINING EXPERIMENTATION AND TO INTEGRATE NEW TRAINING CONCEPTS AND EQUIPMENT INTO NTC WITHOUT SIGNIFICANT IMPACT ON TRAINING SCHEDULE
- MANAGEMENT OF EM SPECTRUM TO AVOID INTERFERENCE WITH GOLDSTONE
- PROVIDE TAKE HOME REMEDIAL TRAINING PACKAGE

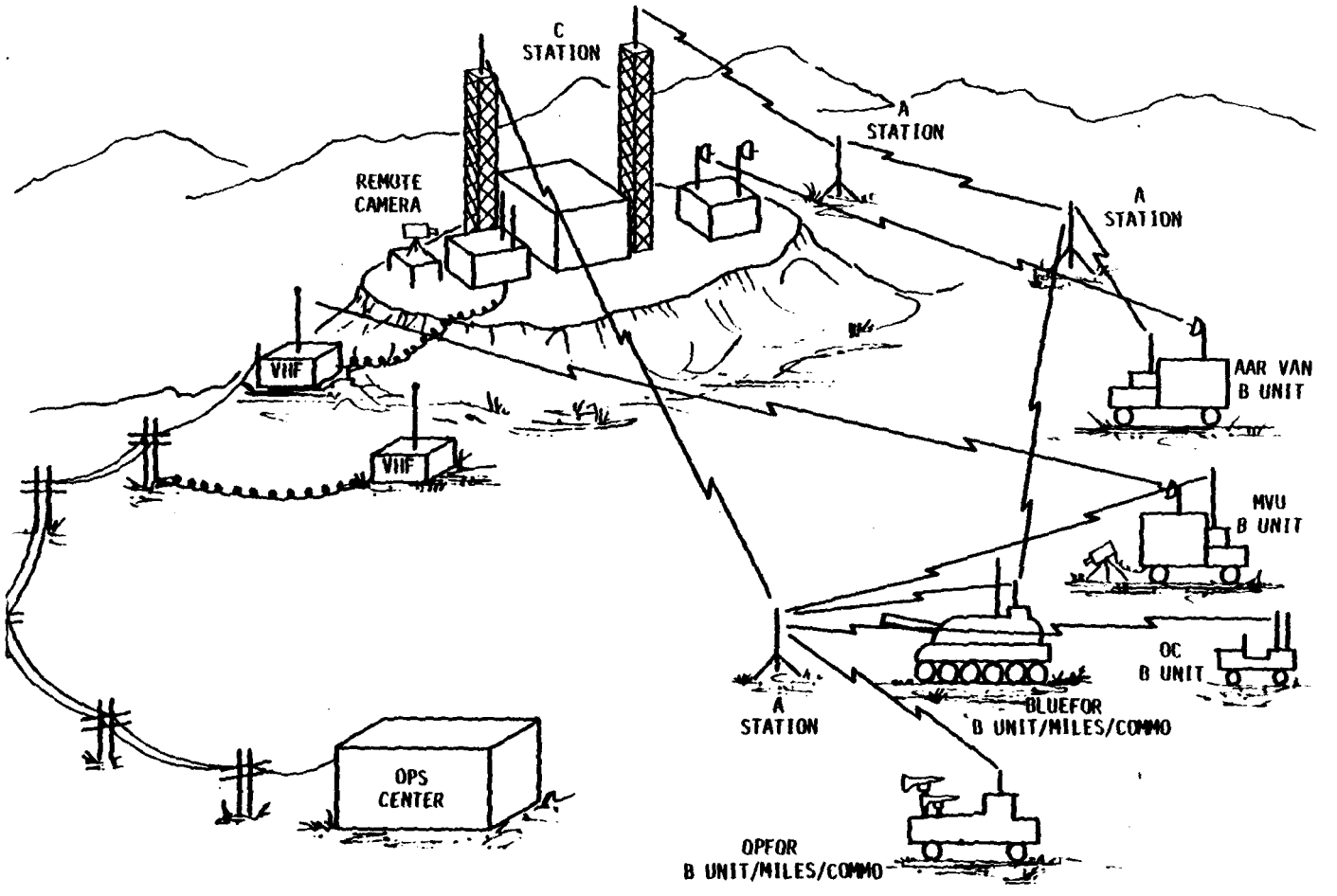


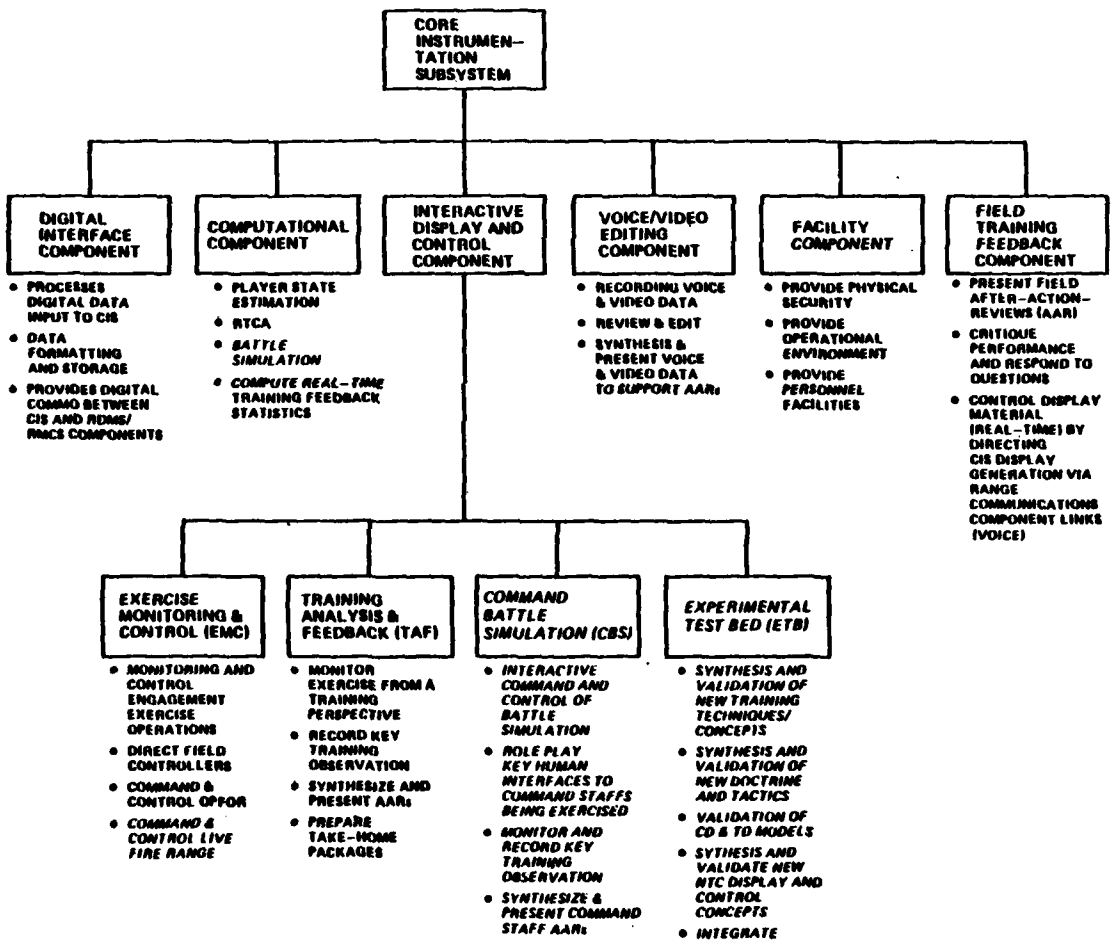
NTC PHASE 1 INSTRUMENTATION SYSTEM ARCHITECTURE



NTC INSTRUMENTATION SYSTEM INTERFACES

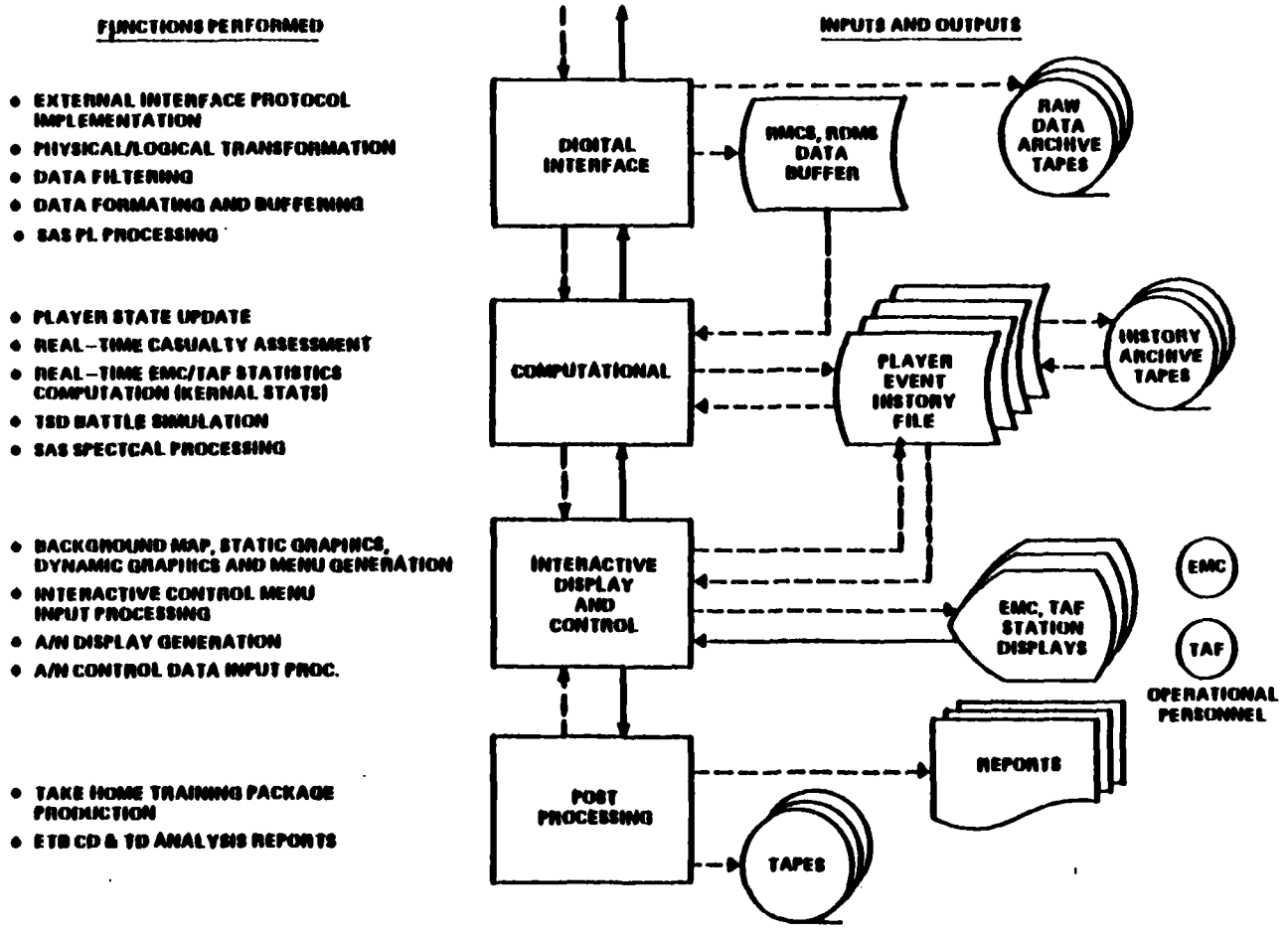
NATIONAL TRAINING CENTER
INSTRUMENTATION SYSTEM



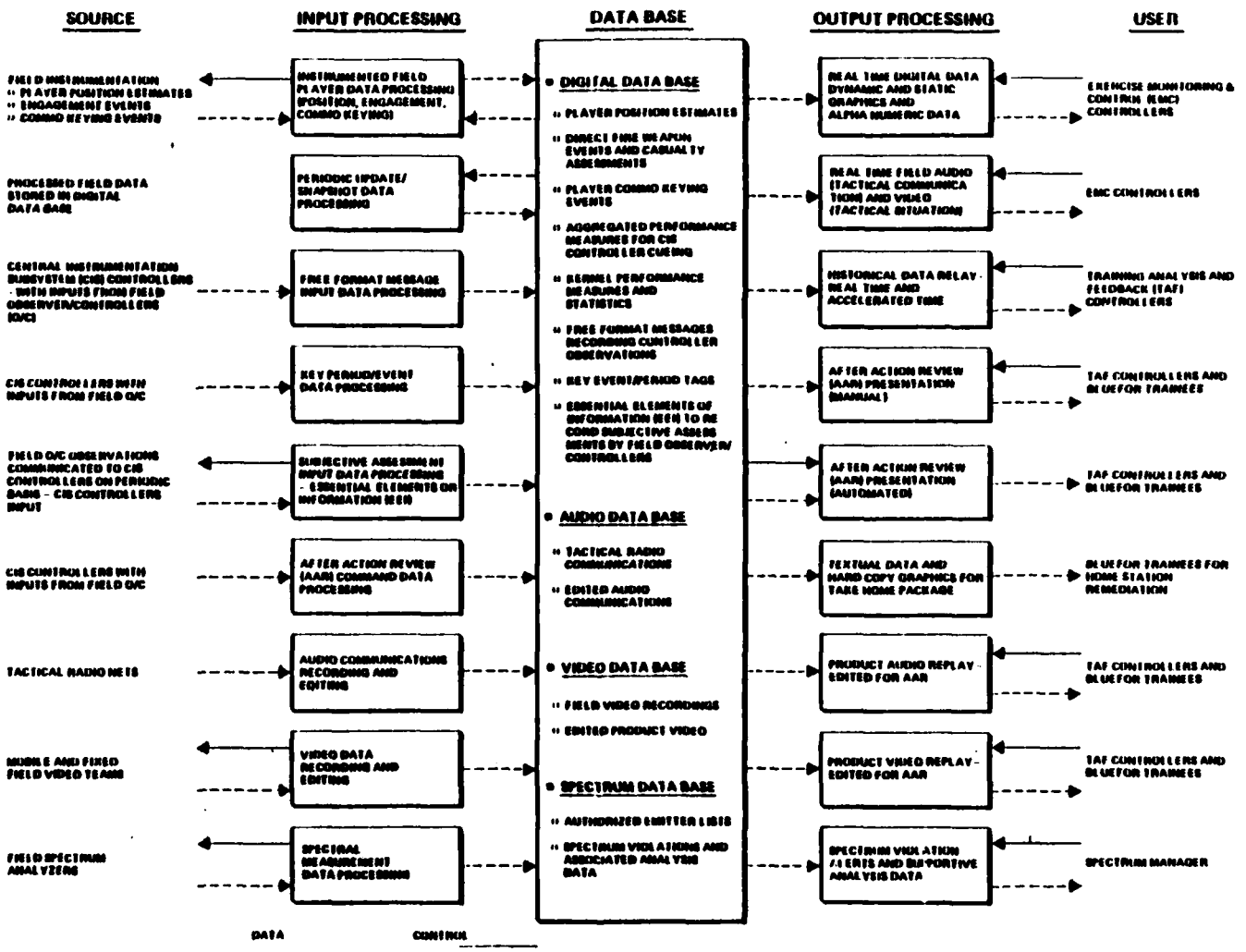


CORE INSTRUMENTATION SUBSYSTEM (CIS) FUNCTIONAL ARCHITECTURE

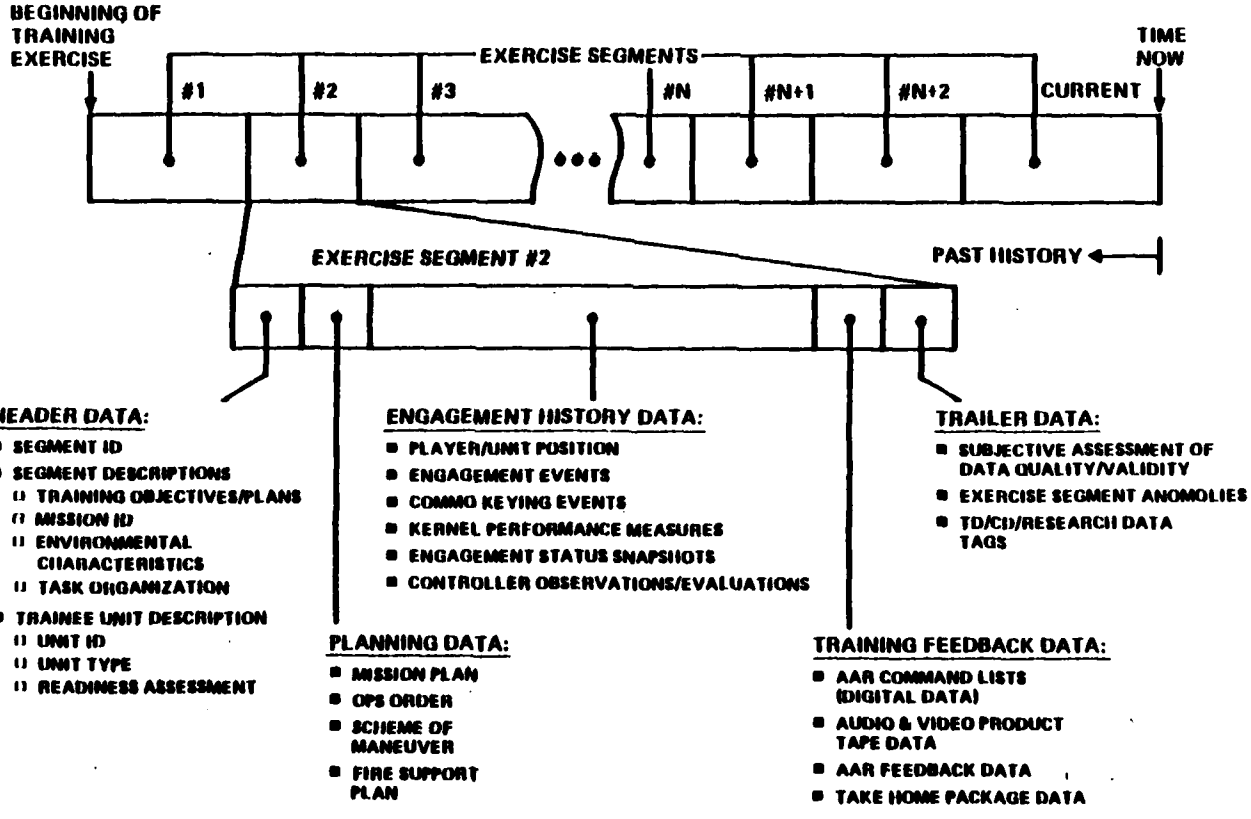
OVERVIEW OF CIS SOFTWARE FUNCTIONAL DESIGN



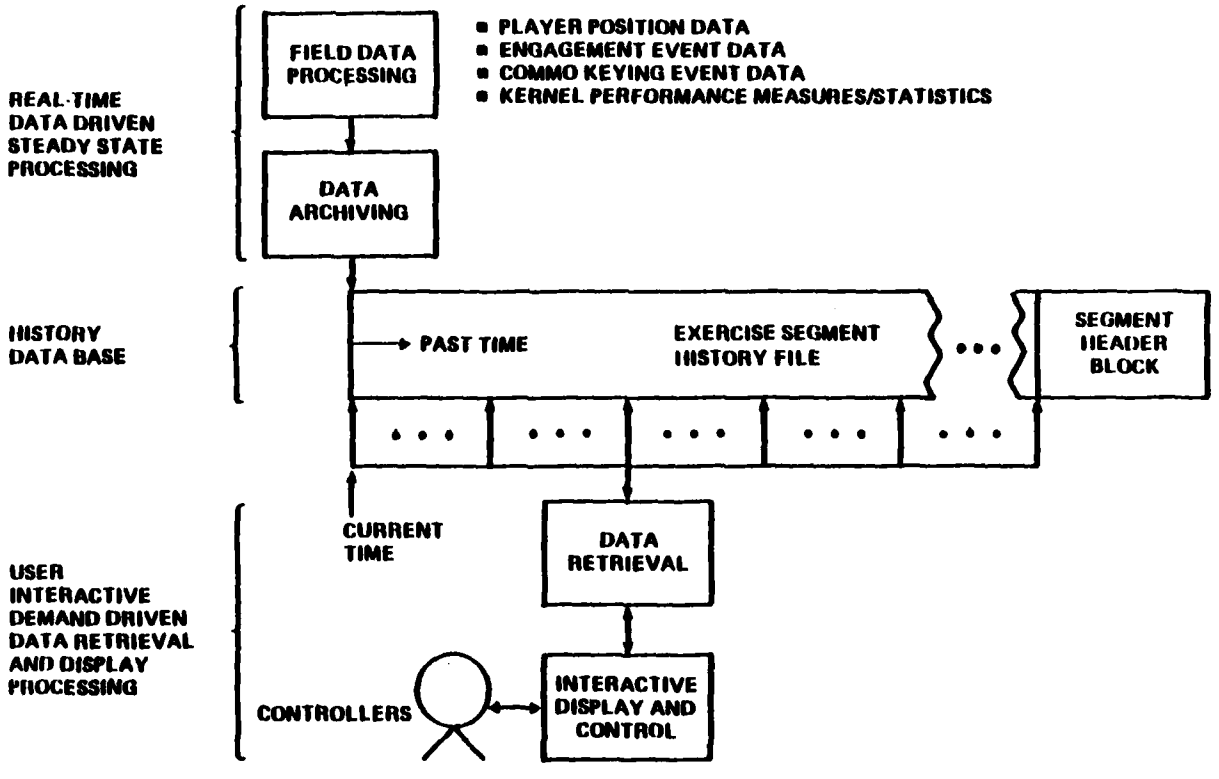
OVERVIEW OF NTC DATA FLOW STRUCTURE

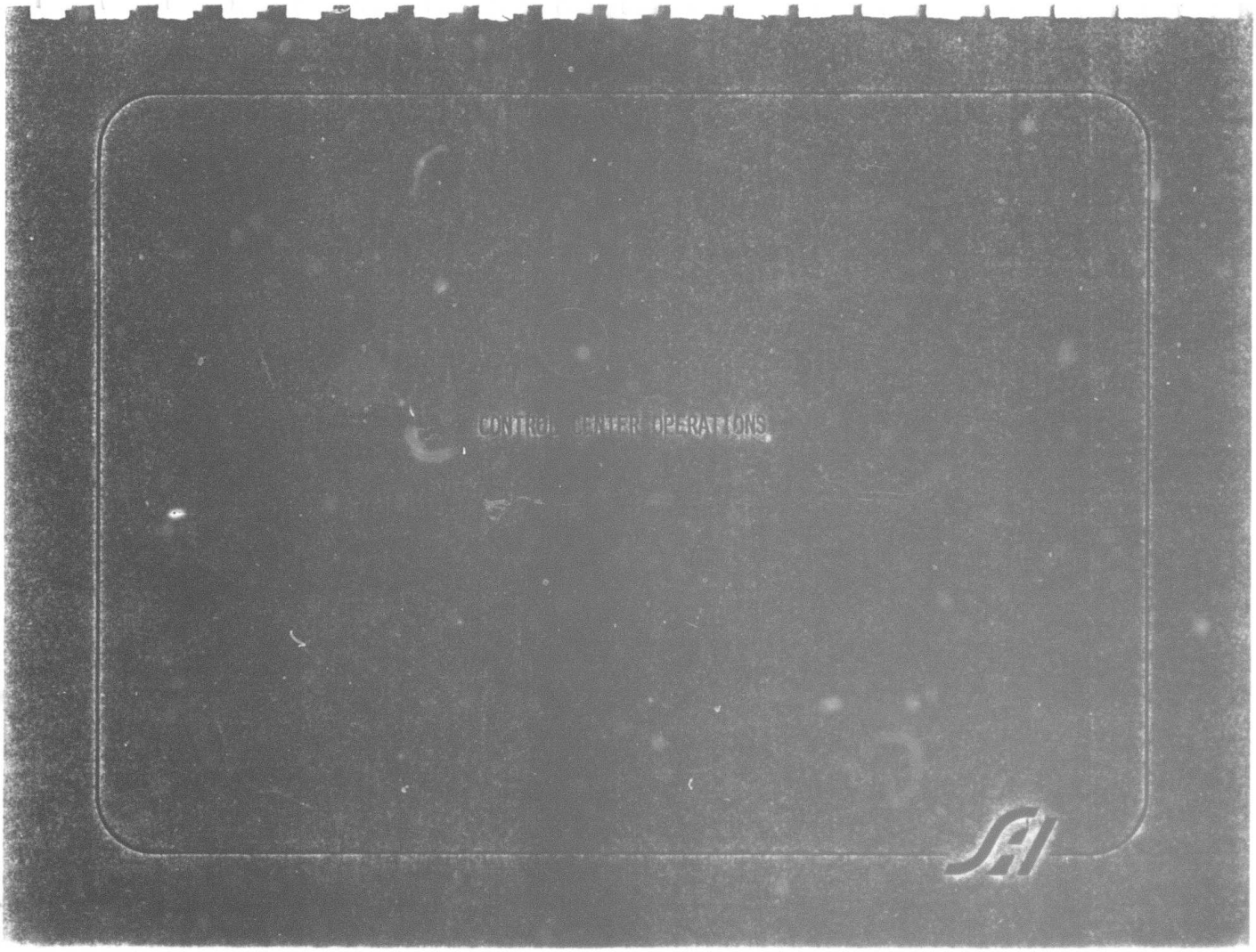


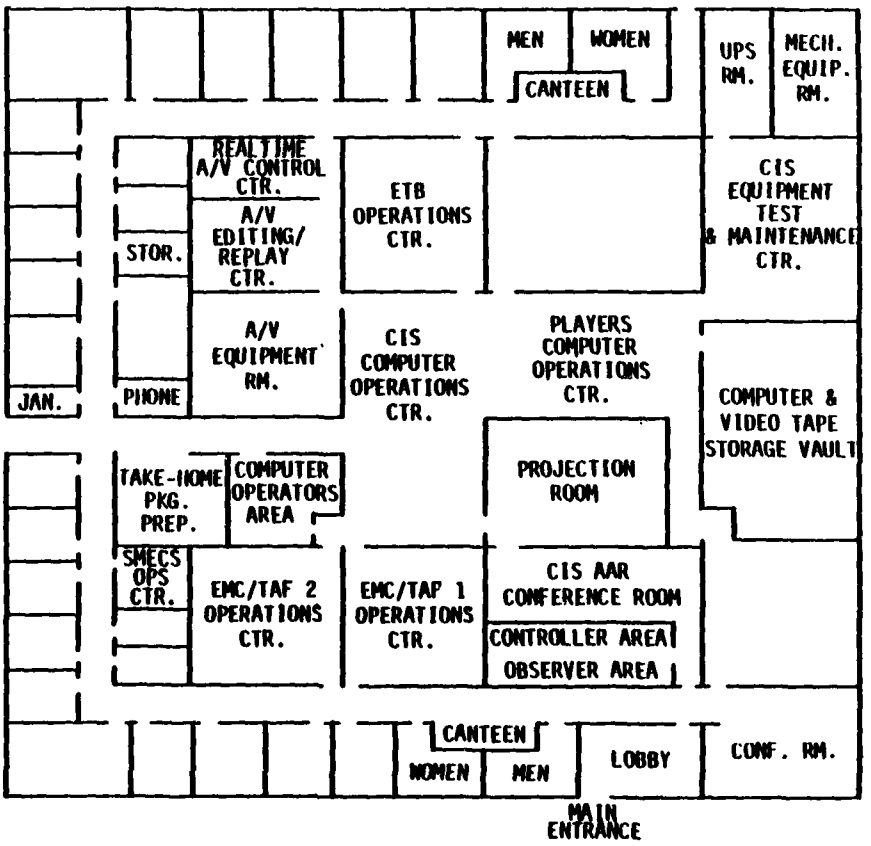
TRAINING HISTORY DATA FILE STRUCTURE



NTC DATA PROCESSING CONCEPT




CONTROL CENTER OPERATIONS



FLOOR PLAN - CIS ENVIROMENTAL PROTECTION SHELTER (EPS)

FIELD ARTILLERY OPERATIONS - BLUEFOR ON OPFOR
FIELD ARTILLERY OPERATIONS - BLUEFOR ON BLUEFOR
4.2 INCH MORTAR FIRE OPERATIONS - BLUEFOR ON OPFOR
4.2 INCH MORTAR FIRE OPERATIONS - BLUEFOR ON BLUEFOR
SINGLE TASK - COBRA/TOW REQUEST - BLUEFOR ON OPFOR
EXTENDED OPERATION - COBRA/TOW REQUEST - BLUEFOR ON OPFOR
COBRA/TOW OPERATIONS - BLUEFOR ON OPFOR
PREPLANNED CLOSE AIR SUPPORT REQUEST - BLUEFOR ON OPFOR
IMMEDIATE CLOSE AIR SUPPORT REQUEST - BLUEFOR ON OPFOR
CLOSE AIR SUPPORT OPERATIONS - BLUEFOR ON OPFOR
AIR DEFENSE OPERATIONS - BLUEFOR ON OPFOR
FIELD ARTILLERY/MORTAR LOCATION - BLUEFOR
VULCAN LOCATION - BLUEFOR
MANPAD LOCATION - BLUEFOR
ENGINEER LOCATION
MINEFIELD/BARRIER LOCATION - BLUEFOR
GROUND SURVILLANCE RADAR (GSR) LOCATION - BLUEFOR
TRAINS LOCATION (CO/BN MOVE COMPLETE) - BLUEFOR
MINEFIELD CASUALTIES/EFFECTS - BLUEFOR
EQUIPMENT STATUS - BLUEFOR

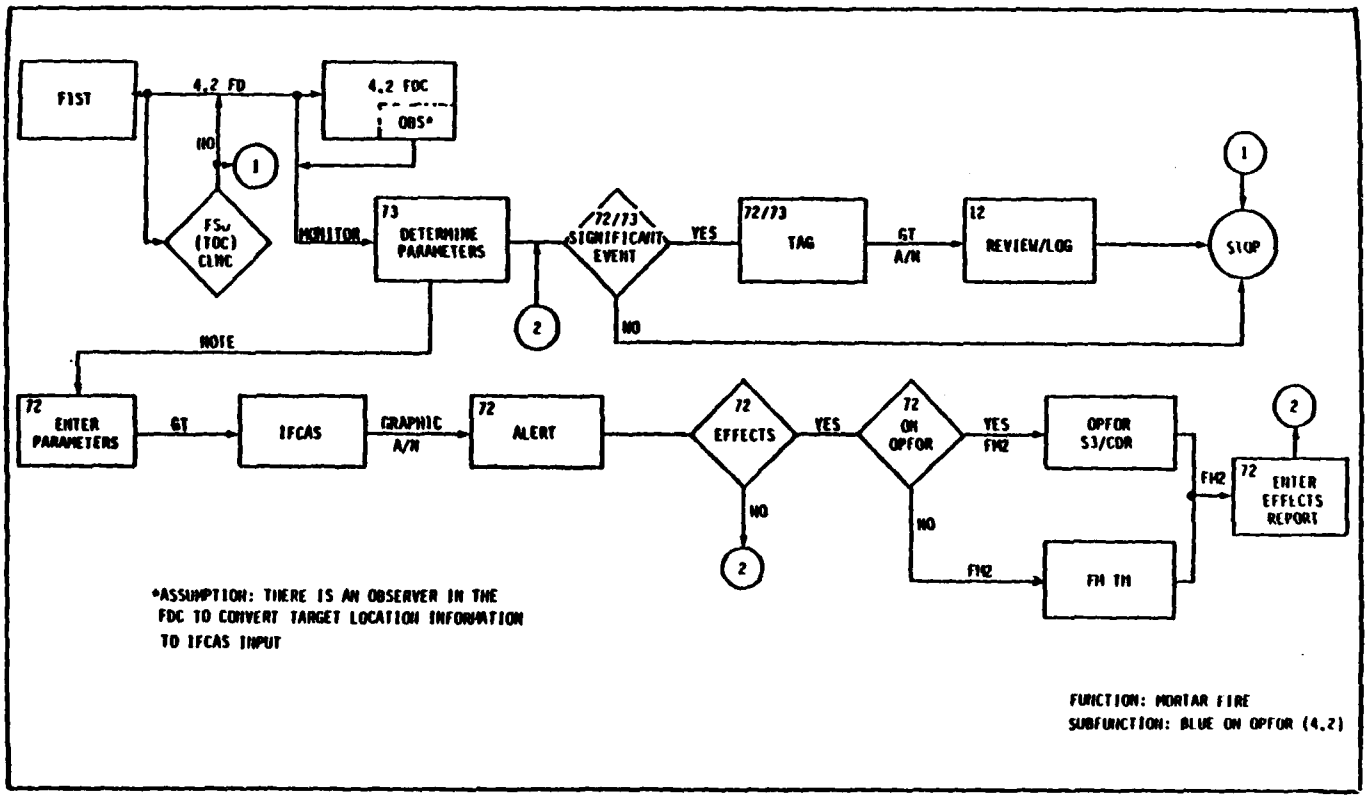
OPERATIONAL ACTIVITIES

SAI

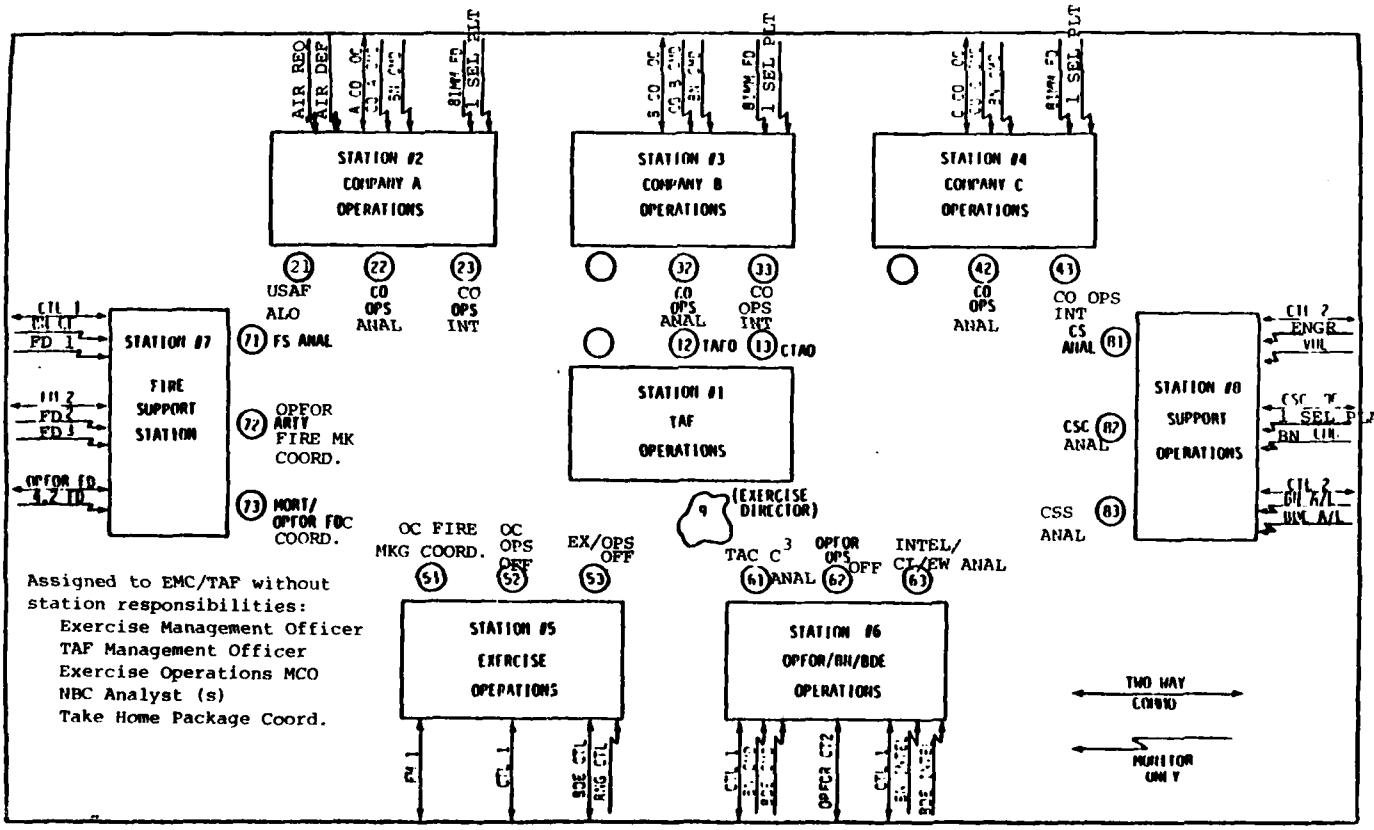
PERSONNEL STATUS - BLUEFOR
NBC ACTIVITY - BLUEFOR
SIGSEC VIOLATIONS - BLUEFOR
COMPANY/PLATOON REPORT - PERIODIC AND EVENT - BLUEFOR
OTHER UNIT/PLAYER REPORT - PERIODIC AND EVENT - BLUEFOR
REVISION OF TASK ORGANIZATION - BLUEFOR
INSTRUMENTATION STATUS CHANGE
FIELD ARTILLERY OPERATIONS - OPFOR ON BLUEFOR
ATTACK HELICOPTER REQUEST - OPFOR ON BLUEFOR
ATTACK HELICOPTER OPERATIONS - OPFOR ON BLUEFOR
CLOSE AIR SUPPORT REQUEST - OPFOR ON BLUEFOR
CLOSE AIR SUPPORT OPERATIONS - OPFOR ON BLUEFOR
FIELD ARTILLERY LOCATION - OPFOR
MINEFIELD/BARRIER LOCATION - OPFOR
MINEFIELD CASUALTIES/EFFECTS - OPFOR
OC QUERY/OPFOR CONTROL
BRIGADE/BATTALION CONTROL
PERIODIC PERFORMANCE REPORTING - OPFOR ON BLUEFOR
REVISION OF TASK ORGANIZATION - OPFOR
OPERATIONAL STATUS CHANGE
AAR DEVELOPMENT

OPERATIONAL ACTIVITIES (CONT'D)

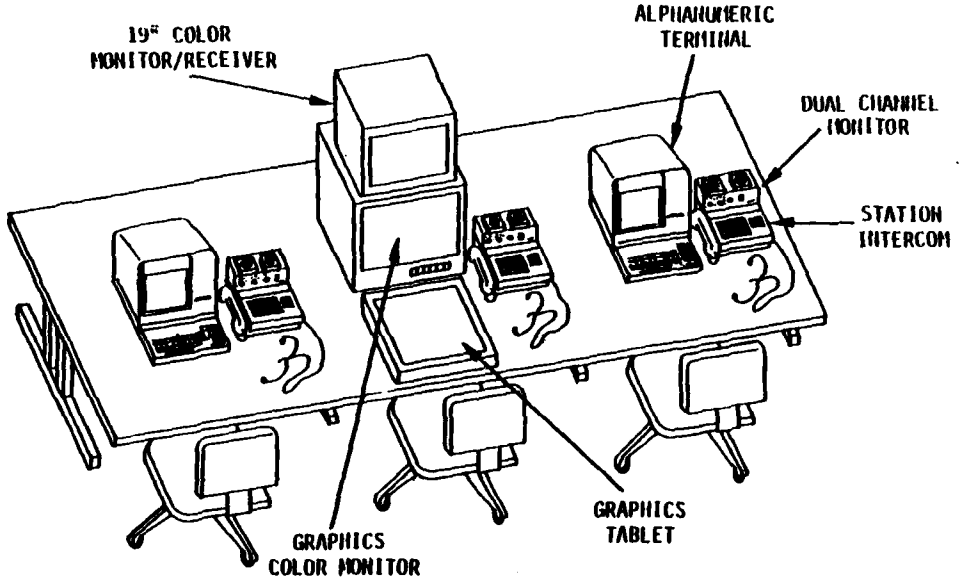
SAI



4.2 INCH MORTAR FIRE OPERATIONS - BLUEFOR ON OPFOR



EMC/TAF OPERATIONS CENTER LAYOUT



EMC/TAF STATION CONFIGURATION

STATION 1: TAF OPERATIONS

OPERATORS AT THIS STATION ARE ALLOCATED THE RESPONSIBILITY TO ANALYZE EXERCISE DATA TO EXTRACT IMPORTANT TRAINING FEEDBACK IN ORDER TO MEET THE TRAINING OBJECTIVES SPECIFIED FOR EACH EXERCISE SEGMENT. THE TRAINING ANALYSIS AND FEEDBACK OFFICER (TAFO) AND HIS ASSISTANTS STRUCTURE AN AFTER ACTION REVIEW (AAR) AND BUILD MATERIAL TO FILL OUT THIS AAR STRUCTURE DURING AN ON-GOING EXERCISE SEGMENT.

STATIONS 2, 3, AND 4: COMPANY OPERATIONS

OPERATORS AT THESE STATIONS ARE ALLOCATED THE RESPONSIBILITY TO MONITOR AND ANALYZE THE ACTIVITIES OF EACH OF THE THREE BLUEFOR LINE COMPANIES AND THEIR SUBORDINATE PLATOONS. NOTE: USAF AIR LIAISON OFFICER, POSITION 21, IS RESPONSIBLE FOR COORDINATION OF ALL CLOSE AIR SUPPORT OPERATIONS.

STATION 5: EXERCISE OPERATIONS

OPERATORS AT THIS STATION ARE ALLOCATED THE RESPONSIBILITY TO MONITOR AND CONTROL THE TRAINING ENVIRONMENT. THESE RESPONSIBILITIES INCLUDE DIRECTING THE OBSERVER/CONTROLLERS (OC) AND FIRE MARKING TEAMS, AND MONITORING THE STATUS OF THE NTC INSTRUMENTATION HARDWARE AND SOFTWARE.

STATION 6: OPFOR, BATTALION AND BRIGADE OPERATIONS

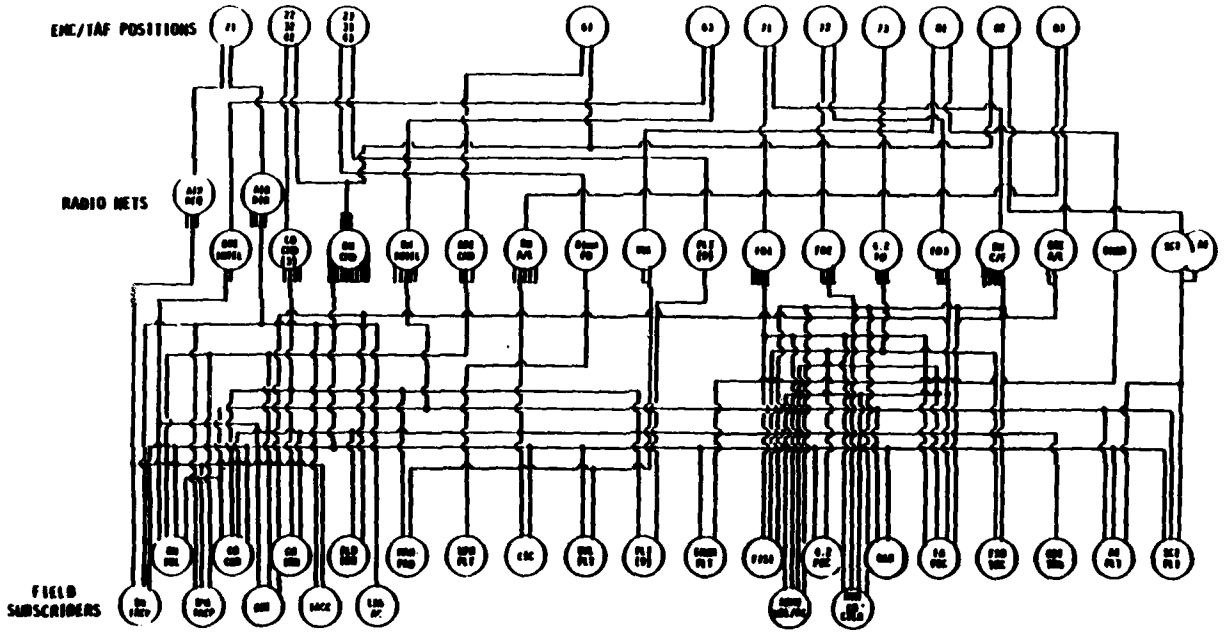
OPERATORS AT THIS STATION ARE ALLOCATED THE RESPONSIBILITY TO DIRECT THE OPPOSING FORCES (OPFOR) AND MONITOR BLUEFOR BATTALIONS AND BRIGADE TACTICAL AND INTELLIGENCE OPERATIONS. WHEN NUCLEAR, BIOLOGICAL, OR CHEMICAL EFFECTS ARE PLAYED, THE NBC ANALYST IS ACCOMMODATED AT THIS STATION.

STATION 7: FIRE SUPPORT OPERATIONS

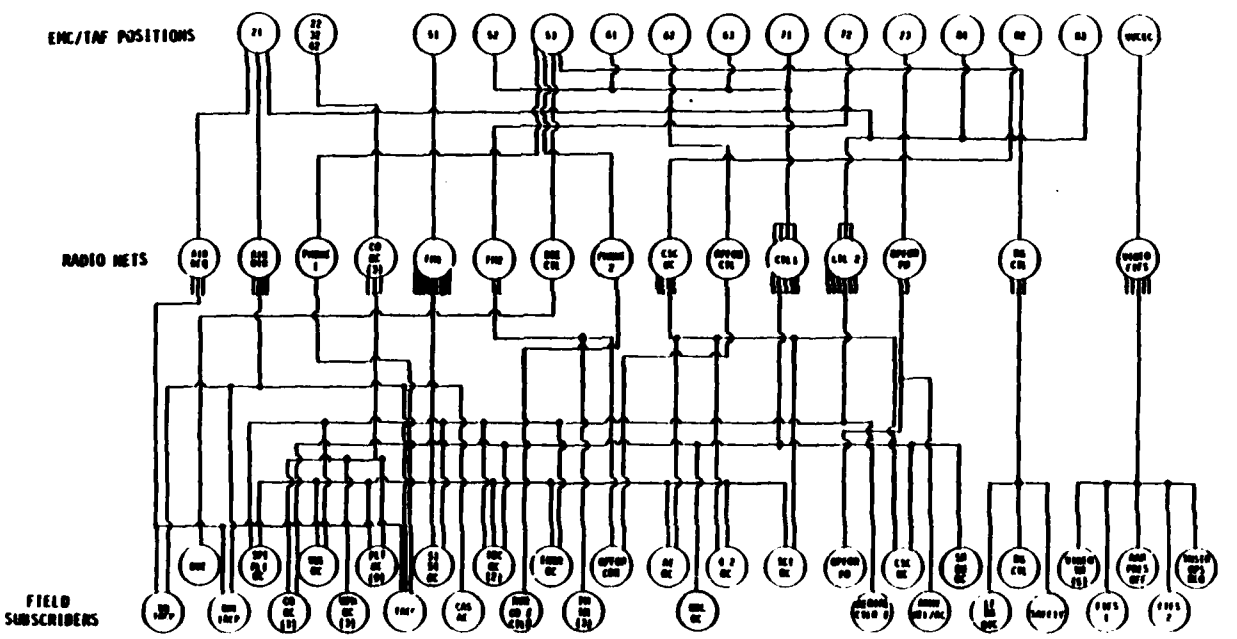
OPERATORS AT THIS STATION ARE ALLOCATED THE RESPONSIBILITY TO MONITOR AND DIRECT THE SIMULATION OF INDIRECT FIRE OPERATIONS FOR BOTH THE BLUEFOR AND OPFOR.

STATION 8: SUPPORT OPERATIONS

OPERATORS AT THIS STATION ARE ASSIGNED THE RESPONSIBILITY TO MONITOR AND ANALYZE ALL BLUEFOR COMBAT SUPPORT AND COMBAT SERVICE SUPPORT OPERATIONS.



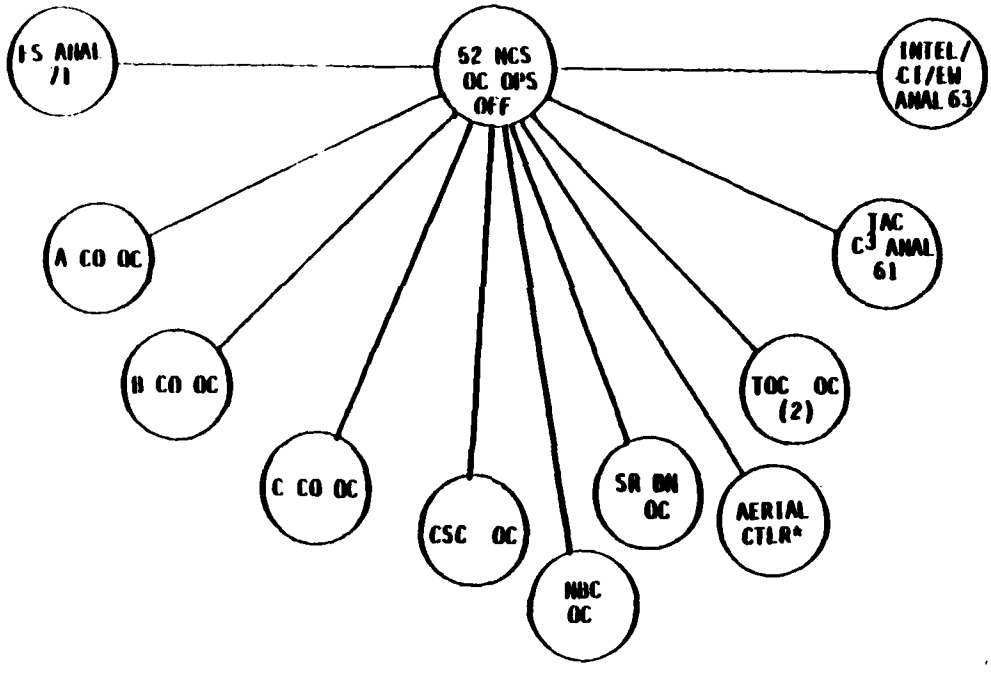
RADIO NET SUBSCRIBER ALLOCATION-TACTICAL



COMMUNICATION NET SUBSCRIBER ALLOCATION-CONTROL

AERIAL CONTROLLER WILL ACCESS CTL/OC NETS REQUIRED. (PRINCIPAL USE NET IS CTL 2.)

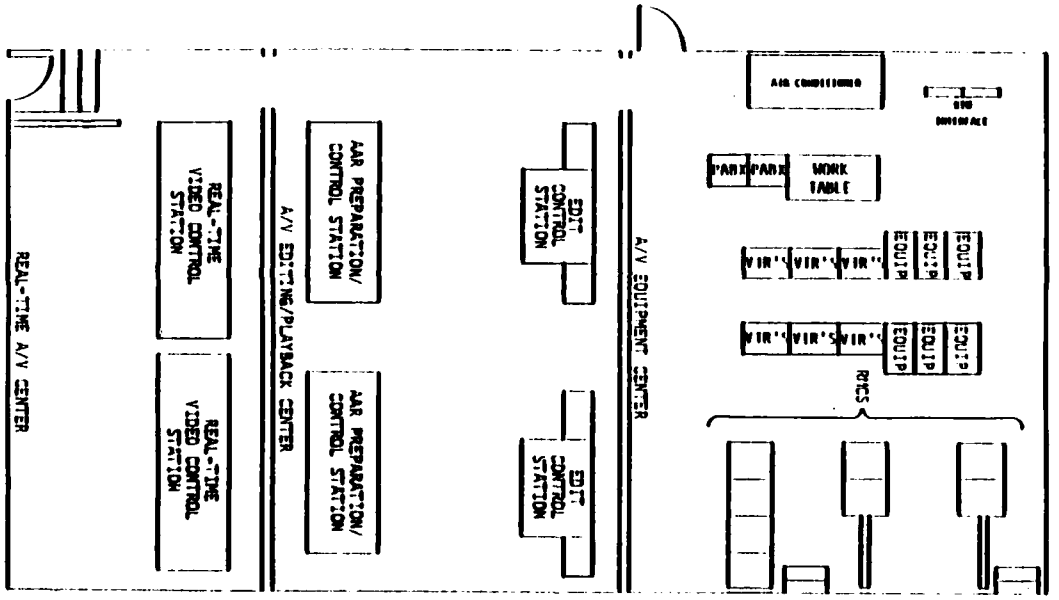
CONTROL 1



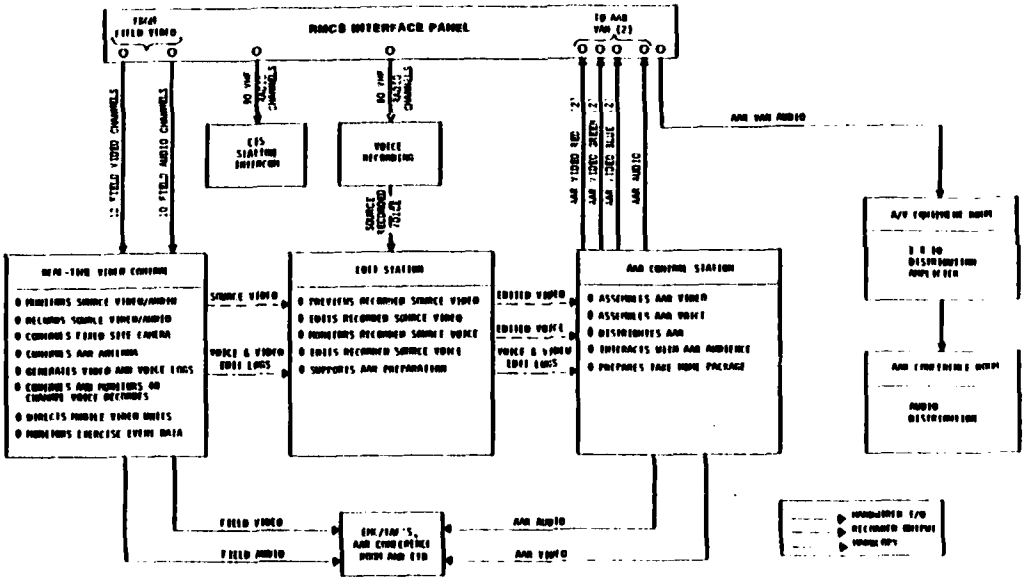
Purposes:

* enters net as required.

To alert and control OCs from the CIS.
To send feedback from the senior TF and TOC OCs to the battalion staff functional analysts in the CIS.
For the senior OC to control key subordinates.



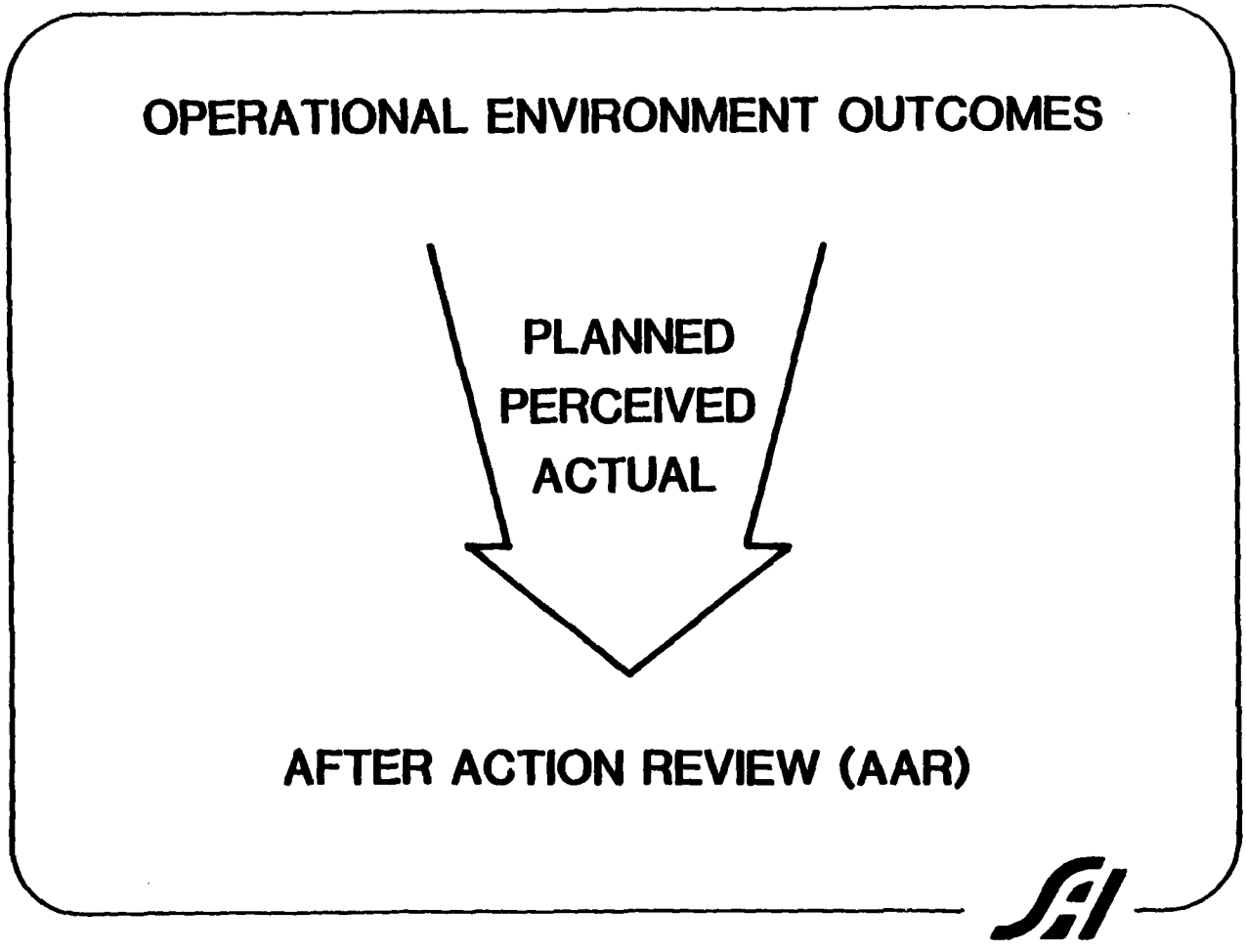
VOICE/VIDEO CONTROL & EDITING COMPONET LAYOUT

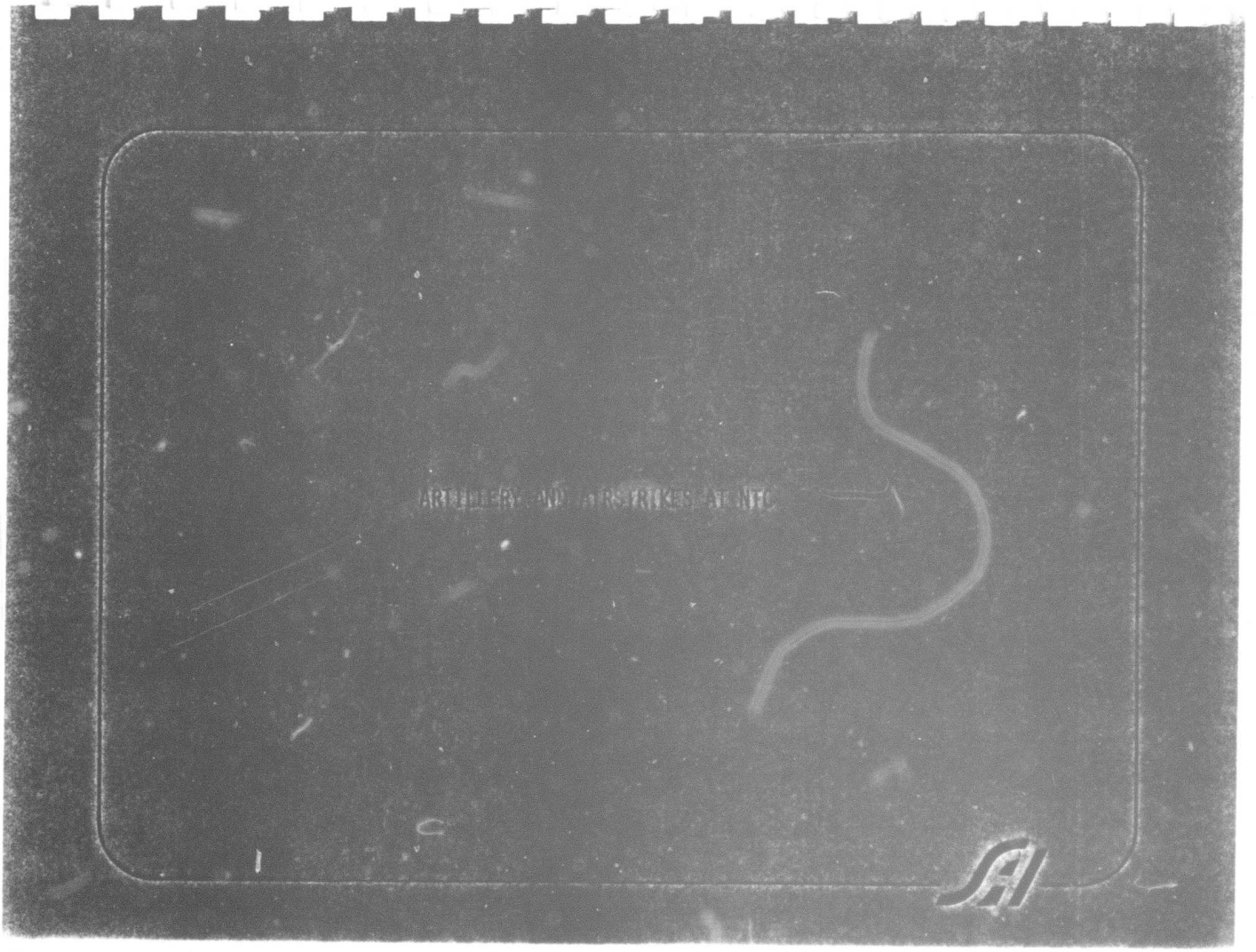


NTC AUDIO/VIDEO INTERFACES, FUNCTIONS AND DISTRIBUTION

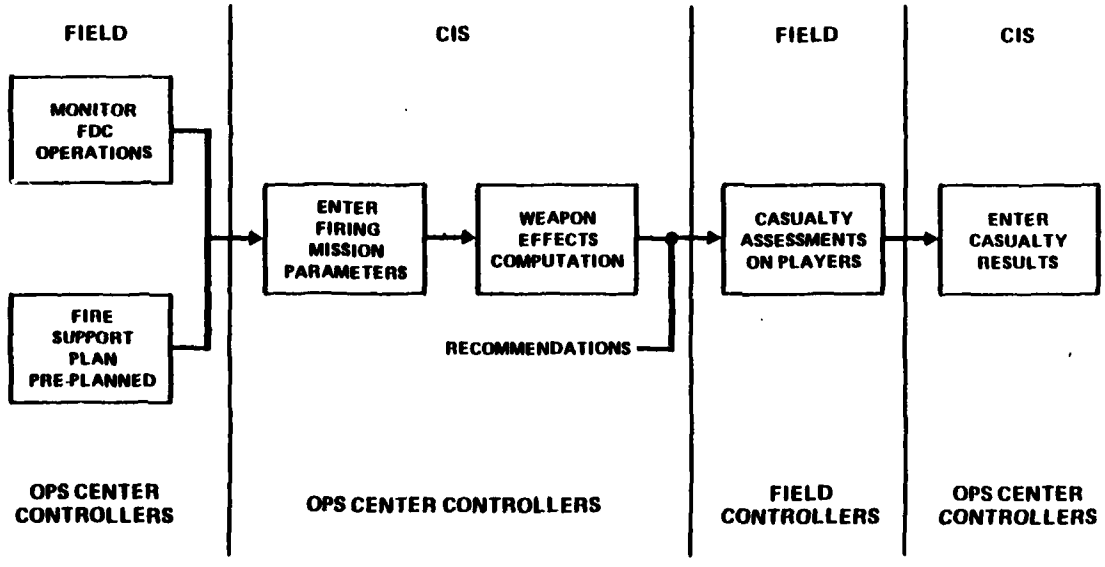
VOICE/VIDEO CONTROL & EDITING COMPONENT FUNCTIONS

- PROVIDES INTERFACE FOR EXTERNAL SOURCES (TO/FROM)
- DISTRIBUTES SOURCE VOICE AND VIDEO
- MONITORS SOURCE VOICE AND VIDEO
- RECORDS SOURCE VOICE AND VIDEO
- EDITS RECORDED SOURCE VOICE AND VIDEO
- PREPARES AFTER ACTION REVIEW
- DISTRIBUTES AFTER ACTION REVIEW
- PREPARES TAKE HOME PACKAGE
- ARCHIVES RECORDED VOICE AND VIDEO


OPERATIONAL ENVIRONMENT OUTCOMES
PLANNED
PERCEIVED
ACTUAL
AFTER ACTION REVIEW (AAR)



INDIRECT FIRE OPERATIONS



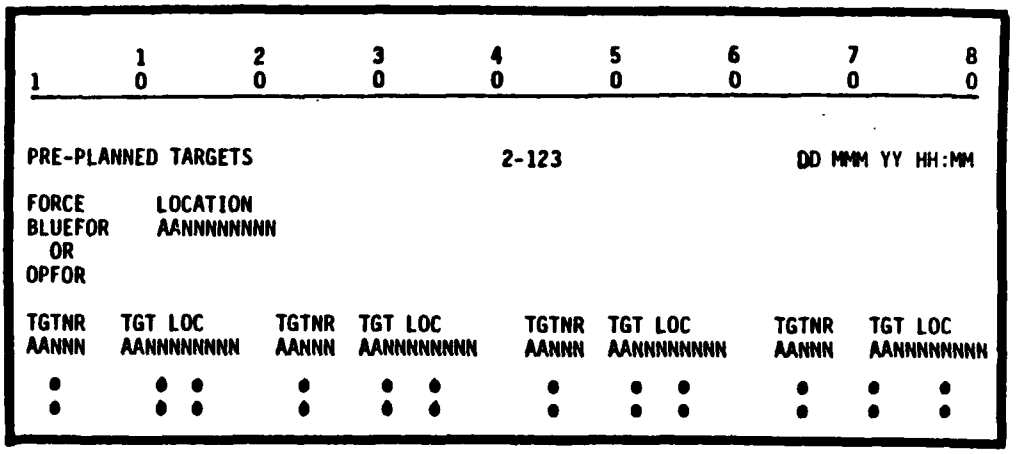
INDIRECT FIRE CASUALTY ASSESSMENT (IFCAS) - SOFTWARE CAPABILITIES

- PRE-PLANNED TARGET LIST MAINTENANCE
- TARGET GROUP LIST MAINTENANCE
- INDIRECT FIRE MISSION MAINTENANCE/PROCESSING

PRE-PLANNED TARGET LIST

- 1,000 TARGETS
  - 500 BLUEFOR
  - 500 OPFOR
- EACH TARGET:
  - FORCE
  - TARGET NUMBER
  - TARGET LOCATION

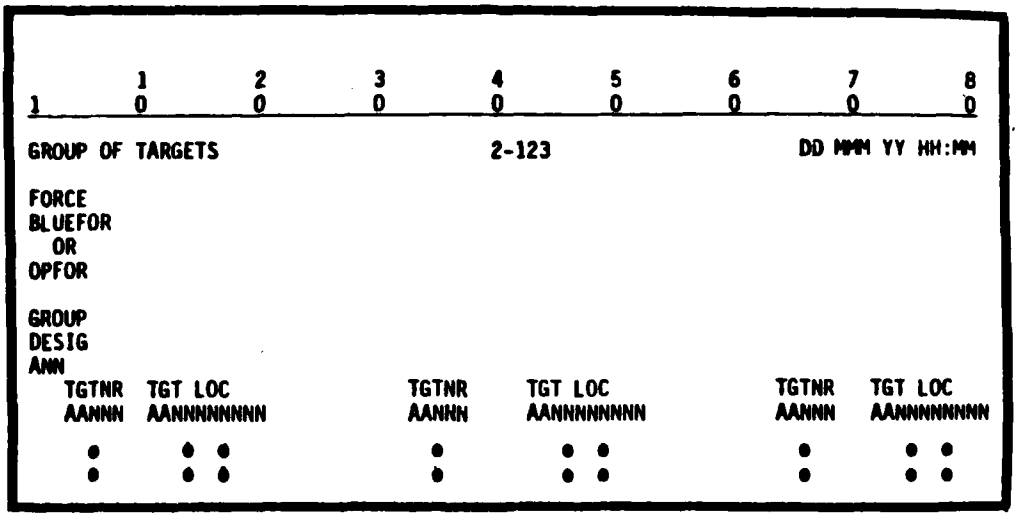
TARGET LIST DISPLAY



TARGET GROUP LIST

- 50 GROUPS
- EACH GROUP:
  - FORCE
  - GROUP DESIGNATION
  - UP TO 10 TARGETS

TARGET GROUP DISPLAY



INDIRECT FIRE MISSION - MAINTENANCE/PROCESSING

- MAINTENANCE
  - 500 ACTIVE MISSIONS
    - SCHEDULED
    - ON-CALL
    - IMMEDIATE
  - EACH MISSION:
    - FORCE
    - TARGET/GROUP
    - FIRING UNIT
    - WEAPON
    - SHELL
    - FUSE
    - # ROUNDS
    - CHARGE (BLUEFOR 155 MM ONLY)
    - TIME/TARGET SERIES (SCHEDULED MISSION ONLY)
  - LIST EDIT/UPDATE

INDIRECT FIRE MISSION - MAINTENANCE/PROCESSING, CONT.

- PROCESSING
  - RANGE CHECK
  - CASUALTY ASSESSMENT (JMEM METHODOLOGY)
    - LOOK-UP TABLE:
      - WEAPON
      - FUSE
      - # ROUNDS
      - FIRER-TARGET RANGE
      - TARGET TYPE
  - ALERT GENERATION
  - FIRING VECTOR DISPLAY
  - LOG MAINTENANCE (MAX 1,600 LOG ENTRIES)

Effectiveness Data - Indirect Fire, Observer Adjusted

RANGE (M)	EXPECTED FRACTION OF CASUALTIES																					
	NUMBER OF VOLLEYS																					
	BTRY 1,2						BTRY 3,4,5						BTRY 6,7,8						BTRY 9,10			
	PERS'L			VEH			PERS'L			VEH			PERS'L			VEH			PERS'L			VEH		
	S	P	F	TNK	PC	WH	S	P	F	TNK	PC	WH	S	P	F	TNK	PC	WH	S	P	F	TNK	PC	WH
1-4,000																								
4,001-7,000																								
7,001-10,000																								
10,001-12,000																								
12,001-14,000																								
14,001-16,000																								
16,001-18,100																								

Weapon: 155mm Howitzer (M109)
Formation: 6 Gun-Lazy W
Projectile: HE
Fuse: VT
Target: Personnel - Open Terrain
* Materiel - Open Terrain
Target Radius: 100 Meters

*For Materiel: TNK=T-55
PC=FROG 4 Transporter
WH=157 Truck

IFCAS ALERT MESSAGE

[TIME] : [FIRING UNIT] : [WEAPON] : [SHELL/FZ] : [TGT#/COORD] :
[TIME OF EXECUTION]
INSTRUMENTED KILLS : [PLAYER ID]; [PLAYER ID] . . .
UNINSTRUMENTED PERS CAS : STAND [NN%] PROT [NN%]
UNINSTRUMENTED VEH CAS : TNK [NN%] APC [NN%] WHEEL [NN%]

E.G.,
10:24:30 : A/4-37 : 155MM : ILLUM/PD : AJ002/NJ34566139 : 10:25:00
INSTRUMENTED KILLS : BTNK:A05;BTOW:A03
UNINSTRUMENTED PERS CAS : STAND 5% PRONE 0% PROT 0%
UNINSTRUMENTED VEH CAS : TNK 0% APC 3% WHEEL 5%

FIRE SUPPORT LOG DISPLAY

```
        1         2         3         4         5         6         7         8
1       0         0         0         0         0         0         0         0

FIRE SUPPORT LOG                          2-123   DD MMM YY HH:MM - DD MMM YY HH:MM

 TIME       TGTNR   TGT LOC    FIRING UNIT    SHELL/FUSE  ROUNDS
DD HH:MM    AANNN AANNNNNNNN  XX/NN-HNN      AAAAAA/AA     NNN
  EFFECT:  WIA:NN KIA:NN (VEHICLE N)__ (VEHICLE N)__ (VEHICLE N)__ (VEHICLE N)__
  INSTRUMENTED LOSS:  PLAYER ID  PLAYER ID  PLAYER ID
```

AIRSTRIKES

- AIR PLAY NOT IMPLEMENTED CURRENTLY
- AIRSTRIKES CASUALTY ASSESSMENT
  - AIR/GROUND ENGAGEMENT SIMULATION (AGES)
  - COMPUTER SIMULATION


DIGITAL
DATA BASE

STANDARD DMA DATA PRODUCTS

- DTED - DIGITAL TERRAIN ELEVATION DATA
  - LEVEL 1 TERRAIN ELEVATIONS IN METERS OR FEET MSL
    LAT/LONG GRID SYSTEM
    3 SECONDS OF ARC SEPARATION BETWEEN POINTS
    APPROXIMATE RESOLUTION 100 METERS
    DATA AVAILABLE FOR MOST OF CONUS, EUROPE, ASIA
  - LEVEL 2 TERRAIN ELEVATIONS IN METERS OR FEET MSL
    LAT/LONG GRID SYSTEM
    1 SECOND OF ARC SEPARATION BETWEEN POINTS
    APPROXIMATE RESOLUTION 30 METERS
    LIMITED DATA AVAILABLE
- DFAD - DIGITAL FEATURE ANALYSIS DATA
  - LINES OF COMMUNICATION DATA
  - VEGETATION
  - URBAN AREAS
  - RESOLUTION AND FORMAT COMPATIBLE WITH DTED DATA

SAI

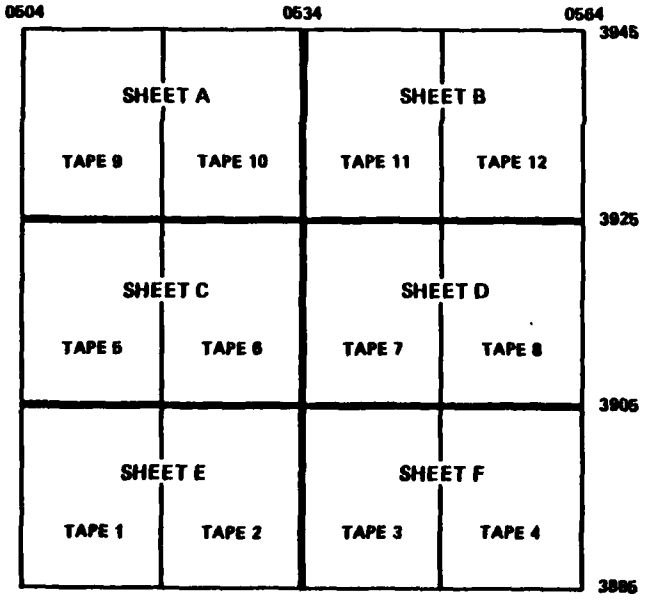
SPECIAL PURPOSE DMA DATA PRODUCT

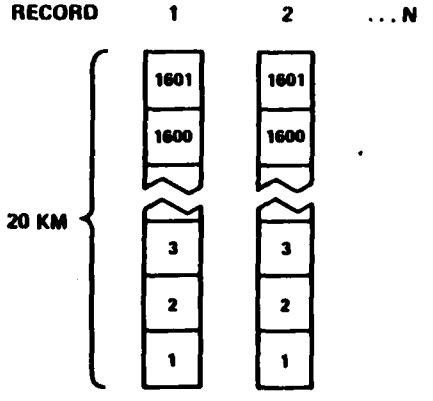
- CATTS/ARTBASS/NTC "FORMAT"
  - 32-BIT GENERAL PURPOSE FORMAT PER DATA POINT
  - 12.5 METER RESOLUTION ON UTM GRID POINTS
  - DATA ORGANIZED IN METER STRIPS SOUTH TO NORTH FOR 20 KM
  - 12 TAPES, 6 FILES, 23 MILLION POINTS, 92 MBYTES (NTC AREA)
  - SOME DATA MISSING, OTHER DATA ERRONEOUS
- AREAS CURRENTLY AVAILABLE
  - NTC - FT. IRWIN, CALIFORNIA
  - FULDA GAP - GERMANY
  - SINAI

NTC DIGITAL TERRAIN NEEDS

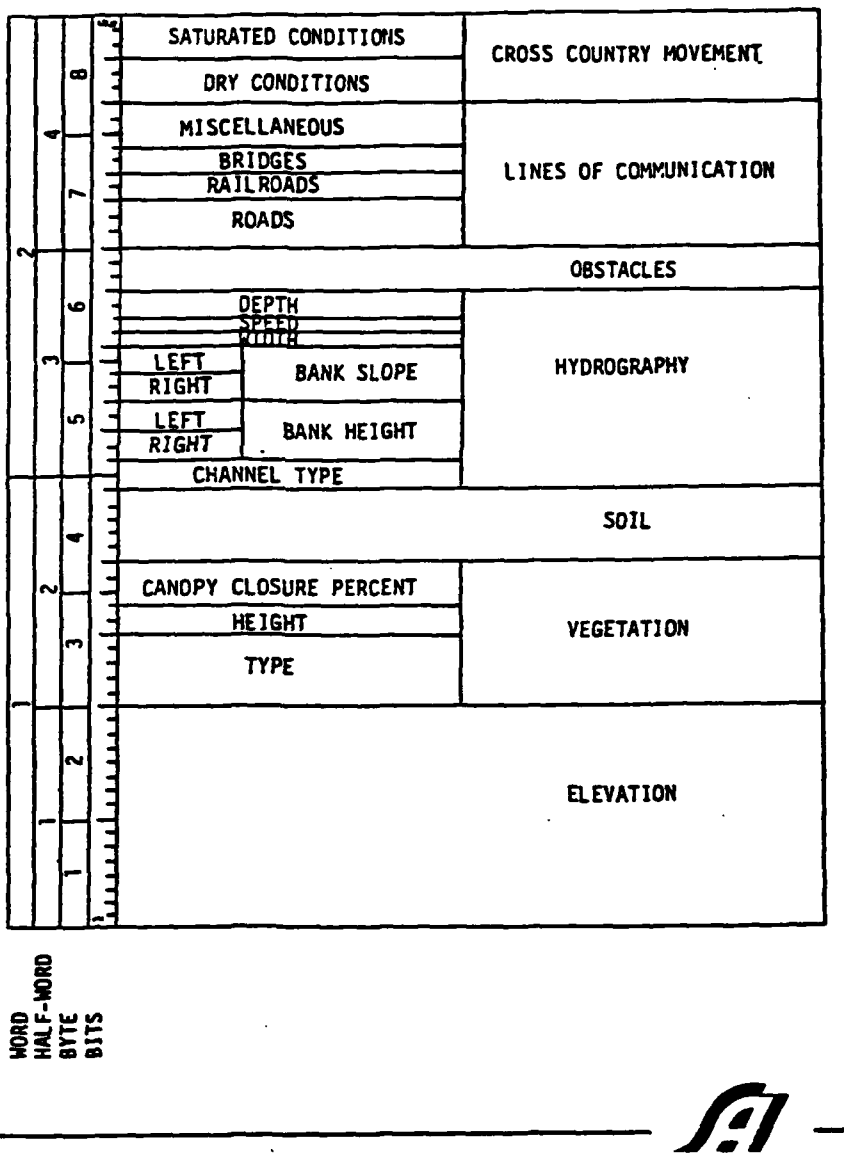
- DISPLAY DATA BASE: DIGITAL BACKGROUND MAPS
  - FOR SITUATION DISPLAYS
- TERRAIN MODEL DATA BASE:
  - INTERVISABILITY CALCULATIONS (LOS/VEGETATION)
  - VEHICLE MOVEMENT
    - CROSS COUNTRY MOBILITY
    - ON-ROAD MOBILITY

DATA ORGANIZATION
DMA ARTBASS DATA





DMA Point Data Format Input



FORMAT OF DEFENSE MAPPING AGENCY (DMA)
SUPPLIED DIGITIZED TOPOGRAPHIC DATA
FOR CATTS AND NTC IMAGE MAP
SOFTWARE SYSTEMS

BIT POSITIONS		DATA DESCRIPTION	DIGITAL CODE
1-16		Elevation (Meters MSL)	
17-26		Surface Features (Vegetation Background)	
	17-21	Type:	
		No data	0
		Agriculture, cropland	1
		Grassland, pasture, meadows	2
		Grassland, scattered trees	3
		Coniferous forest	4
		Deciduous forest	5
		Mixed forest	6
		Forest clearings, cutover areas	7
		Orchards	8
		Vineyards, hop-gardens	9
		Brushland, scrub growth (dense)	10
		Brushland, scrub growth (open)	11
		Wetlands	12
		Peat cuttings	13
		Nearly barren w/widely spaced low growing vegetation	14
		Nearly barren w/closely spaced low growing vegetation	15
		Abandoned agriculture	16
		Bare ground, sand dunes	17
		Unused	18-26
		Mining operations - pits, quarries, strip mines, etc.	27
		Open water	28
		Villages	29
		Towns	30
		Cities	31
	22-23	Heights, average (meters):	
		No data	0
		1-5	1
		5-20	2
		> 20	3

BIT POSITIONS		DATA DESCRIPTION	DIGITAL CODE
	24-26	Canopy closures (%):	
		No canopy	0
		0-25	1
		25-50	2
		50-75	3
		75-100	4
27-31		Surface Materials (Unified Soil Classification System)	
		No data	0
		GW Gravel, well graded	1
		GP Gravel, poorly graded	2
		GM Gravel, silty	3
		GC Gravel, clayey	4
		SW Sand, well graded	5
		SP Sand, poorly graded	6
		SM Sand, silty	7
		SC Sand, clayey	8
		ML Silt	9
		CL Clays	10
		OL Organic silts	11
		MH Inorganic silts	12
		CH Fat clays	13
		OH Fat organic clays	14
		PT Organic, peat	15
		Boulders	16
		Rocky ground	17
		SP Sand Dunes	18
		Bare rock	19
		Rock outcrops	20
		Unused	21-30
		Not evaluated (built up areas, open water, etc.)	31
32-45		Hydrography	
	32-33	Type:	
		No hydrographic features	0
		Stream channel (dry or intermittent)	1
		Lakes, Ponds, Reservoirs	2
		Stream channel (wet)	3
	34-35	Height, Right bank (m):	
		No bank or 0.5	0
		0.5-1.0	1
		1-5	2
		> 5	3

BIT POSITIONS		DATA DESCRIPTION	DIGITAL CODE
	36-37	Height, Left bank (m):	
		No bank or 0.5	0
		0.5-1.0	1
		1-5	2
		> 5	3
	38-39	Slope, Right bank (%):	
		No bank or <30	0
		30-45	1
		45-60	2
		> 60	3
	40-41	Slope, Left bank (%):	
		No bank or <30	0
		30-45	1
		45-60	2
		> 60	3
	42	Gap Width, bank to bank (m):	
		No gap or ≤18.0	0
		> 18.0	1
	43	Water Velocity, average (mps):	
		≤2.5 mps	0
		>2.5 mps	1
	44-45	Water depth, average (m):	
		No water or <0.8	0
		0.8-1.6	1
		1.6-2.4	2
		> 2.4	3
46-48		Obstacles (Normally >5m high & 60% Slope)	
		No obstacles	0
		Road and RR cuts and fills	1
		Natural linear obstacles - escarpments, embankments, dikes, cliffs, etc.	2
		Walls and/or Fences - hedgerows, rock and wire fences and walls, retaining walls, etc.	3
		Other man-made linear obstacles - irrigation and drainage ditches, canals, embankments, etc.	4
		Military obstacles - antitank ditches, airfields, and/or road craters, blown bridges, debris choked valleys and/or towns, impact areas, minefields, roadblocks, trenches, wire entanglements, etc.	5-7

BIT POSITIONS		DATA DESCRIPTION	DIGITAL CODE
49-58		Lines of Communication (LOC)	
	49-51	Roads:	
		No road	0
		1 lane road, unimproved	1
		1 lane road, imprpved	2
		2 lane road, unimproved	3
		2 lane road, improved	4
		2 lane road, paved	5
		3-5 lane road, paved	6
		≥ 6 lane road, paved	7
	52-53	Railroads:	
		No Railroad	0
		Nonstandard Guage	1
		Standard Guage, Single Track	2
		Standard Guage, Multiple Track	3
	54-55	Bridges:	
		No bridge	0
		< Class 30	1
		Class 30-59	2
		Class 60 or higher	3
	56-58	Miscellaneous:	
		No features	0
		Power Station	1
		Dam	2
		Tunnel	3
		Fords - natural	4
		Fords - Improved	5
		Airfield/LZ - natural surface	6
		Airfield/LZ - hard surface	7
59-64		Cross-Country Movement (Est. Max. Speed in mph)	
	59-61	Dry conditions	
		M151 Jeep / M35 Truck / M113 APC / M60 Tank / Foot Troops	
		No data	0
		27-36 / 19-25 / 17-22 / 14-18 / 2.5-3	1
		18-27 / 13-19 / 12-17 / 10-14 / 2.0-2.5	2
		9-18 / 7-13 / 6-12 / 5-10 / 1.5-2.0	3
		0-9 / 0-7 / 0-6 / 0-5 / 0.5-1.5	4
		Passage Blocked <1	5
		Passage Blocked	6
		Built-up area, CCM not evaluated	7

BIT POSITIONS		DATA DESCRIPTION					DIGITAL CODE
	62-64	Saturated Conditions					
		M151 Jeep	M35 Truck	M113 APC	M60 Tank	Foot Troops	
		No data					0
		27-36	19-25	17-22	14-18	2.5-3	1
		18-27	13-19	12-17	10-14	2.0-2.5	2
		9-18	7-13	6-12	5-10	1.5-2.0	3
		0-9	0-7	0-6	0-5	0.5-1.5	4
		Passage Blocked				< 1	5
		Passage Blocked					6
		Built-up area, CCM not evaluated					7

DISPLAY DATA BASE REQUIREMENTS

- 8 BITS PER PIXEL (DATA POINT)
- 5 DISPLAY RESOLUTIONS (12.5, 25, 50, 125, 250 METERS)
- DATA BLOCKED AS 64 X 80 PIXELS (10 DISK BLOCKS)
- LOW RESOLUTION MAPS DECLUTTERED
- SHOW CROSS-COUNTRY MOBILITY (PROVIDED BY DMA)
- SHOW SHADED RELIEF (ONLY ELEVATION DATA PROVIDED)
- SHOW CONTOUR LINES
- SHOW FEATURES/BOUNDARIES NOT PROVIDED BY DMA

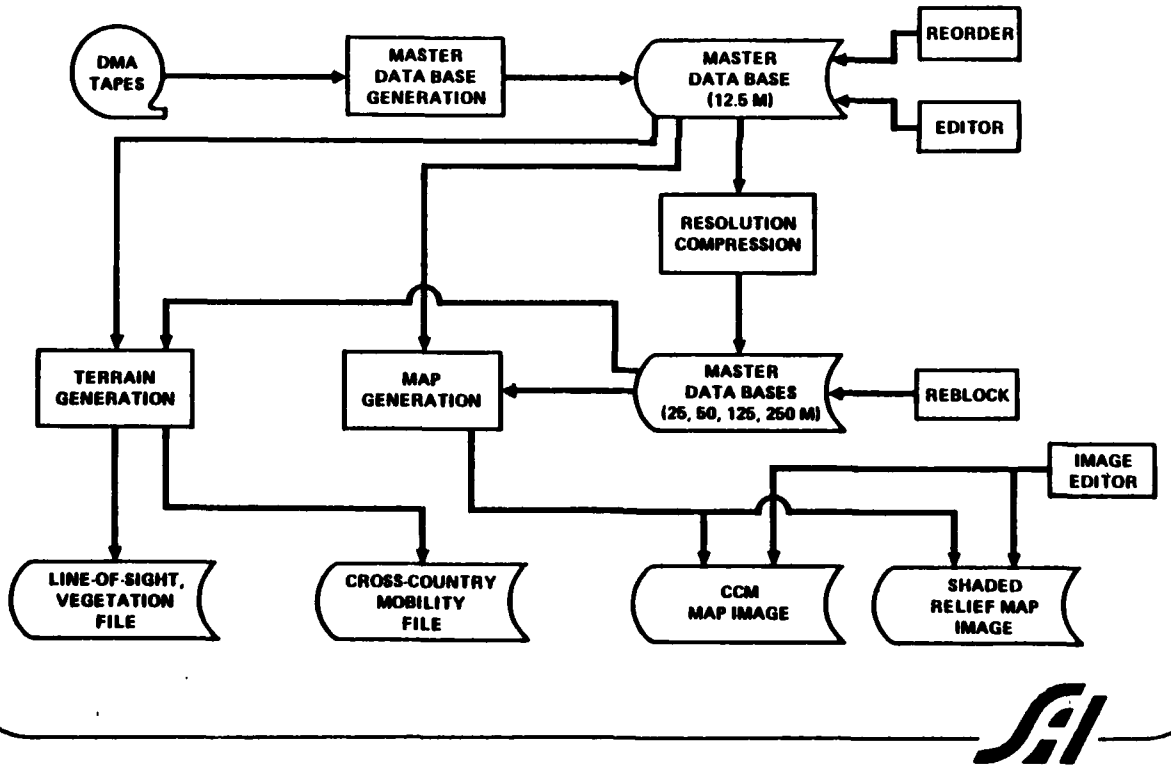
TERRAIN MODEL DATA BASE REQUIREMENTS

- CROSS-COUNTRY MOBILITY DATA
  - MOBILITY CODES (SLOPE, SOIL TYPE, VEGETATION, ETC.)
  - HYDROGRAPHIC CLASS
  - ROAD, RAILROAD CODES
- LINE-OF-SIGHT DATA
  - ELEVATIONS
  - VEGETATION CODES
- 25 METER RESOLUTION
- DATA BLOCKED 3.3 KM X 3 KM
  (132 X 120 POINTS)

APPROACH OVERVIEW

- COMPRESS DATA TO MANAGEABLE SIZE
- REORGANIZE DATA TO DISPLAY-ORIENTED BLOCKS
- MOVE FROM TAPE TO DISK FILES QUICKLY
- USE EXTENSIVE INTERACTIVE QUALITY CONTROL TOOLS
- DEVELOP ALGORITHMS TO COMPUTE CONTOURS AND SHADED RELIEF

PROCESSING FLOW



PROCESSING STEPS

FILE	PROCESS
• DMA TAPES (ARTBASS FORMAT)	• MASTER DATA BASE GENERATION - COMPRESS 64 BITS TO 32 BITS - ENCODE DATA - FORM 64 X 80 BLOCKS FROM 1 X 1601 RECORDS
	• REORDER DATA - CONVERT ORGANIZATION OF DATA BLOCKS TO A SINGLE FILE OF 60 X 75 BLOCKS
	• MASTER DATA BASE EDITOR - CORRECT ERRONEOUS DATA - SUPPLY MISSING DATA
• MASTER DATA BASE (12.5 METERS)	• RESOLUTION COMPRESSION - 2:1 OR 5:1 SCALE COMPRESSION - DATA PRIORITY SCHEME

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PROCESSING STEPS, CONT.

FILE	PROCESS
• MASTER DATA BASES (ALL RESOLUTIONS)	• REBLOCK - RESTORE COMPRESSED FILES TO 64 X 80 BLOCKS • MAP GENERATION - EXTRACT DATA - CONVERT DATA - DECLUTTER - GENERATE CONTOURS
• DESIRED MAP FILES - CROSS-COUNTRY MOBILITY - SHADED RELIEF	• IMAGE EDITOR - CORRECT ERRONEOUS DATA - ADD OR MODIFY DATA

PROCESSING STEPS, CONT.

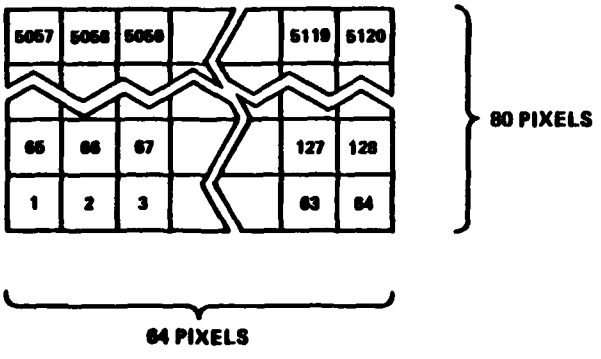
FILE	PROCESS
• MASTER DATA BASES (ALL RESOLUTIONS)	• TERRAIN GENERATION - EXTRACT DATA - CONVERT DATA - REBLOCK
• DESIRED TERRAIN MODEL FILES - CROSS-COUNTRY MOBILITY - LINE-OF-SIGHT	

DISPLAY SCALES AND RESOLUTIONS

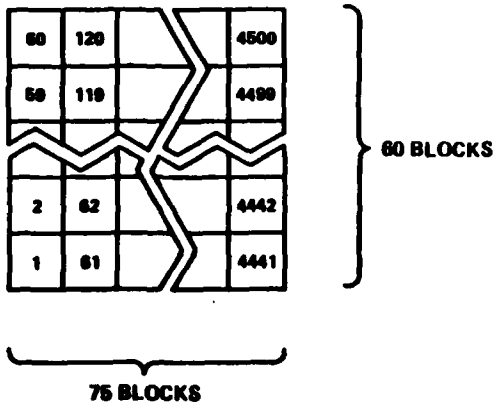
DISPLAY LEVEL	RESOLUTION (METERS PER PIXEL)	DISPLAY (KM)	DISPLAY SCALE
1	12.5	6.4 X 6	1:25,000
2	25.0	12.8 X 12	1:50,000
3	50.0	25.6 X 24	1:100,000
4	125.0	64.0 X 60	1:250,000
5	250.0	128.0 X 120	1:500,000

DATA ORGANIZATION
NTC MAP DISPLAY DATA

DATA WITHIN BLOCKS



BLOCKS WITHIN DISPLAY FILE (DISPLAY LEVEL 1)



DISPLAY CODES

CODE/COLOR	DESCRIPTION	
	CCM	SHADED RELIEF*
0	-	A, A
1	-	A, B
2	1	A, C
3	1	A, D
4	1	A, E
5	1	-
6	1	-
7	1	-
8	2	B, A
9	2	B, B
10	2	B, C
11	2	B, D
12	2	B, E
13	2	-
14	3	-
15	3	-
16	3	C, A
17	3	C, B
18	3	C, C
19	3	C, D
20	4	C, E
21	4	-
22	4	-
23	4	-
24	4	D, A
25	4	D, B
26	5	D, C
27	5	D, D
28	5	D, E
29	5	-
30	5	-
31	5	-
32	6	E, A
33	6	E, B
34	6	E, C
35	6	E, D
36	6	E, E
37	6	-
38	-	-

*A = Steep negative slope
B = Shallow negative slope
C = New level slope
D = Shallow positive slope
E = Steep positive slope

DISPLAY CODES (CONTINUED)

CODE/COLOR	DESCRIPTION	
	GENERAL	SPECIFIC
39	Water	Streams (dry)
40	Water	Lakes, ponds, etc.
41	Water	Streams (wet)
42	Areas	Villages
43	Areas	Towns
44	Areas	Cities
45	Roads	1-lane, unimproved
46	Roads	1-lane, improved
47	Roads	2-lane, unimproved
48	Roads	2-lane, improved
49	Roads	2-lane, paved
50	Roads	> 2 lane, paved
51	RR	Non-standard guage
52	RR	Standard guage, single track
53	RR	Standard guage, multi-track
54	Bridges	Class $\leq$30
55	Bridges	Class 31-59
56	Bridges	Class $\geq$60
57	Misc	Power Station
58	Misc	Dams
59	Misc	Tunnels
60	Misc	Fords - natural
61	Misc	Fords - improved
62	Misc	AF/LZ - natural
63	Misc	AF/LZ - improved
64 - 127	Contours	
128 - 255	Grid Lines	

TERRAIN DATA BASE STRING

GIVEN DATA RESOLUTION OF 25 METERS:

- LINE-OF-SIGHT (ELEVATION PLUS VEGETATION)
  - 2 BYTES PER POINT
  - 1 KM^2 = 40 X 40 POINTS = 1,600 POINTS = 3,200 BYTES
- CROSS-COUNTRY MOBILITY
  - 1 BYTE PER POINT
  - 1 KM^2 = 40 X 40 POINTS = 1,600 POINTS = 1,600 BYTES
- TERRAIN DATA PER KM^2 = 4,800 BYTES
- ASSUME MAXIMUM RANGE OF 5 KM (ANY DIRECTION)
  - 10 KM X 10 KM = 100 KM^2 = 480 KBYTES